Mechanical World —— February 1958

Data for Design

THE more it becomes necessary to design structures and machine parts which make full use of the material of which they are composed, the greater is the need for accurate knowledge of the applicability of the physical properties of the materials. Obviously, if a part is to be light in weight it must be highly stressed, and equally obviously it must be capable of withstanding that stress. As things are it is not sufficient to rely on the metallurgist to produce stronger and less dense materials: the materials themselves must be thoroughly understood. The simple-stress tests which were satisfactory in the factor-of-safety era do not provide sufficient information for this understanding and recourse has long been had to full-scale testing to get definitive performance data. This, however, is no more than jumping from one end to the other of what ought to be a consistent body of knowledge the vital middle part of which is missing.

The theories of the behaviour of metal under stress are based on elastic deformation, plastic flow or creep, cohesive strength, and there are the microcrack theory, the thermodynamic theory, and the dislocation theory. These range over all the observed phenomena but none is comprehensive. As formulated the elastic deformation theory only applies to certain materials and only to one phase of their stress/strain characteristic. In practice it is known that complex structures do not conform to this precept and consequently an indeterminately wide margin has to be left for the ignorance factor which goes by the name "safety". Plastic flow theory is still evolving and is applied mostly to particular materials under particular temperature conditions. The cohesive theory reveals the enormous strength of the single crystal which can only fail by the atomic bond being overcome. The microcrack theory is again based on elastic considerations but is only matched by the behaviour of very brittle materials. The thermodynamic theory seeks to relate physical characteristics to the melting energy of the metal. Finally, the dislocation theory makes up for the practical deficiencies of some of the others by taking account of lattice imperfections.

A good deal can be done with all these theories, but there is no comprehensive and accurate basis for practical design. Each theory is very largely a study of one simple property or of an assumed property, whereas reality involves material in the mass with non-uniform stress and often considerable variation of section.

In addition to the inadequacy of theory, there is a further disadvantage in that in the testing of materials, it is the simple and exclusive properties which are measured. The combined effect in practical design for high duty is to produce a number of failures, and the object then can only be to reduce that number to an inconsiderable minimum, comprising so few, in fact, that they can be filtered out by inspection.

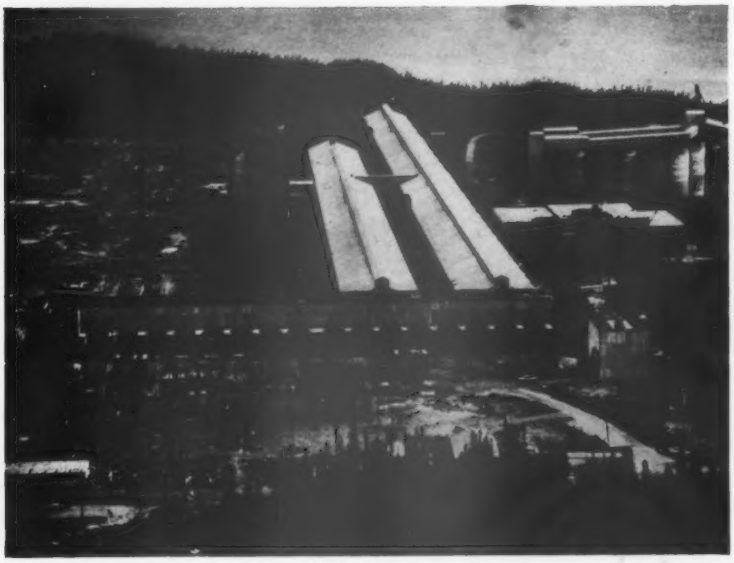
As it happens, much of the day-to-day engineering design does not require any great amount of investigation in order to produce an adequate and workable result. Any designer knows, however, that he depends much on precedent—rather more, perhaps, than on theory. When precedent is lacking or insufficiently indicative, then with theory as a guide he has recourse to experiment. This is all right for a prototype for quantity manufacture, but it involves delay, and is no good for the one-off job or to meet different dimensions or conditions.

Altogether, the fact is that tests on materials, and the theories of materials, are much more pure than practical. Realistic testing and applicable theory have yet to be found, and while a lot of work has been done on the subject the needs of present-day practical design suggest that there is much more to be tackled.

LOG SHEET

New Canadian Aluminium Smelter

Less than 20 months after work commenced on clearing the site, the first metal was poured at the new aluminium smelter of the Canadian British Aluminium Company at Baie Comeau in the Province of Quebec on the north shore of the St. Lawrence River, 400 miles north-east of Montreal. One of Britain's most important investments in Canada in recent years, the company is a subsidiary of the British Aluminium Company Limited and has been formed in partnership with one of Canada's largest pulp and paper companies, the Quebec North Shore Paper Company.



The first two of the eight smelter bays at Baie Comeau each of which is one-third of a mile long. The third bay is also under construction. The switchyard is in the foreground with the rectifier room running horizontally across the rear end of the smelter bays. Ancillary buildings and alumina silos are on the right

The event marked the completion of the first of four production stages of the £50 million plant which will eventually have an annual capacity of 160,000 long tons of virgin aluminium ingot. As an indication of the size of the smelter, this ultimate capacity represents two-thirds of the present annual consumption of virgin aluminium ingot in the United Kingdom.

The two furnace rooms for Stage I are more than 1700 ft long with a rectifier house at one end and a casting shop at the other. In addition the plant comprises a carbon factory, laboratory, service building, workshops and offices, together with alumina and coke silos. Each furnace room has 84 furnaces of the vertical stub Soderberg type, connected in series.

A 3000 ft belt conveyor handles at present about 125 tons of coke and alumina per hour and its capacity is designed so that this may be raised to 400 tons hourly. Substantial storage space is required owing to the period of closed navigation on the St. Lawrence, making it necessary to store materials for approximately a four month period.

The wharf, which has been in operation since its completion last September, has three 550 ft berths capable of taking vessels up to 10,000 tons. The steel piles which are 80 ft long are reputed to be amongst the largest ever rolled.

Power for Stage I (120,000 hp) and part of Stage II is to be drawn from the nearby Manicouagan Power Company, which is owned 60% by Quebec North Shore Paper Company and 40% by Canadian British Aluminium Company. Three new 50,000 hp generators have been installed raising the total present capacity to 250,000 hp. Quebec-Hydro owned by the Province of Quebec is building a large storage dam some miles up the Manicouagan River at Lake St. Anne, to provide a regulated water supply throughout the year for this expansion. Agreements between Quebec-Hydro and CBA have been completed for the remainder of CBA's power requirements.

NYLON TRANSMISSION BELTING.—After 12 months' use in a Sheffield drop stamp forge this 16 in. × $\frac{7}{16}$ in. hair-and-nylon driving belt showed no signs of wear. A standard hair belt normally lasts about only eight months.

Metal Spraying Dust Control

Messrs. Woods of Colchester practice zinc and aluminium metal spraying in their production of axial flow fans at Colchester. This operation is carried out in booths whose location relative to other activities called for a very high degree of dust and fume control. Bag filters had

been originally employed for dedusting the exhaust air from the booths but whilst reasonably economical performance was attained with aluminium spray dust, the extremely acicular nature of zinc particles gave rise to such a rapid increase in pressure drop across the fabric allied with an ability to cling to the fabric even under conditions of vigorous bag shaking, that the cost of a filter installation capable of satisfying production requirements was prohibitive from capital, running and space considerations. The problem posed to Dallow Lambert & Co. Limited, as specialists in dust control and collection, was to provide a deduster capable of satisfying the requirements economically. The solution was derived through two principal fields of assessment—the physical properties and behaviour of aluminium and zinc dusts and the geographical limitations of the site.

Three methods of dedusting were available: cyclones, fabric filters, and wet dedusters; and the collection efficiency obtainable with all three was calculated following an accurate size analysis of the dusts involved. Cyclones were precluded by their relatively low efficiency and fabric filters were inacceptable for the reasons defined above. A careful evaluation of wet dedusting was undertaken, therefore, and it was found whilst the efficiency obtained with a wet deduster would not be as high as that theoretically obtainable from a fabric filter, because of the unique primary and secondary dedusting systems employed the effluent anticipated from a wet deduster would be sufficiently dilute as to allay fears of secondary problems associated with atmospheric pollution by dust and fume. Critical tests were carried out in the company's pilot plant laboratory and a wet deduster, Series MG type C, was decided upon, with manual sludge removal methods in view of the relatively low volume of dust entrained within the system.

This plant was installed with axial flow fans designed and made by Messrs. Woods of Colchester, in place of a multiblade centrifugal fan. This resulted in a neat and compact arrangement of the outlet header and the fans. A further refinement necessary for use with aluminium metal spray collection was the venting to free atmosphere of any incipient hydrogen generated through the immersion of the collected fine particles in water, the hydrogen concentration within the unit being kept to safe limits; a non-return valve in the air inlet duct prevented any contamination of workshop atmospheres. The area occupied by the wet deduster is just over 1/20 of that necessary for a fabric filter of equal capacity.

H.M.S. Victorious

The reconstruction of the aircraft carrier H.M.S. *Victorious* has been much more fundamental than would normally be expected of any work of the kind and the job must therefore be regarded as decidedly unusual. In the result the ship has her underwater beam increased by eight feet, and the angled deck results in an overall beam of 150 ft. The depth from keel to the flight deck has been increased by four feet. There are two modern steam catapults capable of handling the latest and heaviest Fleet Air Arm aircraft, and two of the most up-to-date deck landing mirror aids.

Larger boilers have been installed to feed the catapults, and increased machinery capacity generally. The main machinery can be remotely operated from a centre supplied with filtered air, this to deal with the conditions attending an atomic attack.

The deck island is relatively small, having been made so to increase the area of the flight deck. It has been done by putting the operations room, radar display room and associated compartments below the flight deck. The beams of the flight deck are deep enough to accommodate these and other office spaces and have enabled the upper gallery deck to be continuous for the full length and width of the ship.

The radar fitted in the *Victorious* has been described as the best ship-borne air defence radar in the world. It combines early warning and high discrimination of an aircraft's position in plan and height simultaneously. A complex semi-automatic electronic system collects and displays the information provided by this radar, enabling the Admiral or Captain to see at a glance the tactical situation in any section of the sky for miles around him. Electronic computors provide greater accuracy in the control of modern high performance fighters operating in greater numbers than ever before. A further new high discrimination radar with a computor is also fitted to "talk down" aircraft safely on to the deck in all weathers.

ASSEMBLY JACK.—An interesting type of electrically operated scissor jack, designed and manufactured by Skyhi Limited, England, to a de Havilland specification, is used in the assembly hall at Hatfield for mounting Comet-4 fuselages on their wings. The fuselage at this stage weighs about 7 tons. Once the wing assembly, comprising centre-section with main-planes attached, is in place the fuselage is lowered on it, and during the last inch of movement it is aligned on "shufflers", ball-bearing-mounted units on the tops of the lifts, to an accuracy of within two-thousandths of an inch in relation to the hole centres for insertion of the attachment bolts. The photograph shows the second Comet-4 being assembled in this way

Pushbutton Normalizing Plant

Amongst the modern production machinery which is being installed in the Scotstoun factories of Albion Motors Limited is an electrically heated pusher furnace for normalizing various types of forgings such as main shafts, countershafts and similar components. Supplied by GWB Furnaces Limited, this normalizing furnace can be regarded as a machine tool from the production aspect.

Owing to the varied nature of the components and the relatively heavy weight-to-size ratio, it was considered that the best type of mechanism for conveying a charge through the furnace was a hydraulically operated pusher to propel the charge trays along the furnace hearth, in which are set heat resisting steel skid rails.

The robust heat resisting steel trays are 2½ ft by 2 ft by 1 ft and carry on average a load of 400 lb. Manual work involved in serving this installation has been reduced to the minimum. The only manual effort required is placing the components into the trays at the charging end of the furnace. A single pushbutton actuates a complete cycle. Another single pushbutton control causes a cross conveyor, at the output end of the oven, to move the discharged tray uphill to the top of an inclined idler roller track running the length of the furnace. Before the tray returns to the front of the furnace, it is unloaded by a tipper into a waiting stillage. When the empty tray has returned down the inclined track, it is loaded by hand and then moved over automatically in front of the entrance door to recommence the cycle.

The oven has a maximum loading of 145 kW which is arranged in three independently controlled zones, each of which is governed by a Cambridge potentiometric indicating controller, while a six-point recording instrument gives a positive check on thermal conditions along the length of the heating and cooling chamber. The heating chamber is 10½ ft long and the cooling section which extends from the end of the heating chamber is 18 ft long.

In order to prevent too rapid cooling on leaving the heating chamber, the first section of the cooling chamber is fitted with a few heating elements so that the required cooling curve is obtained. An hourly output of 600 lb of forgings heated to 900° C is normally achieved.

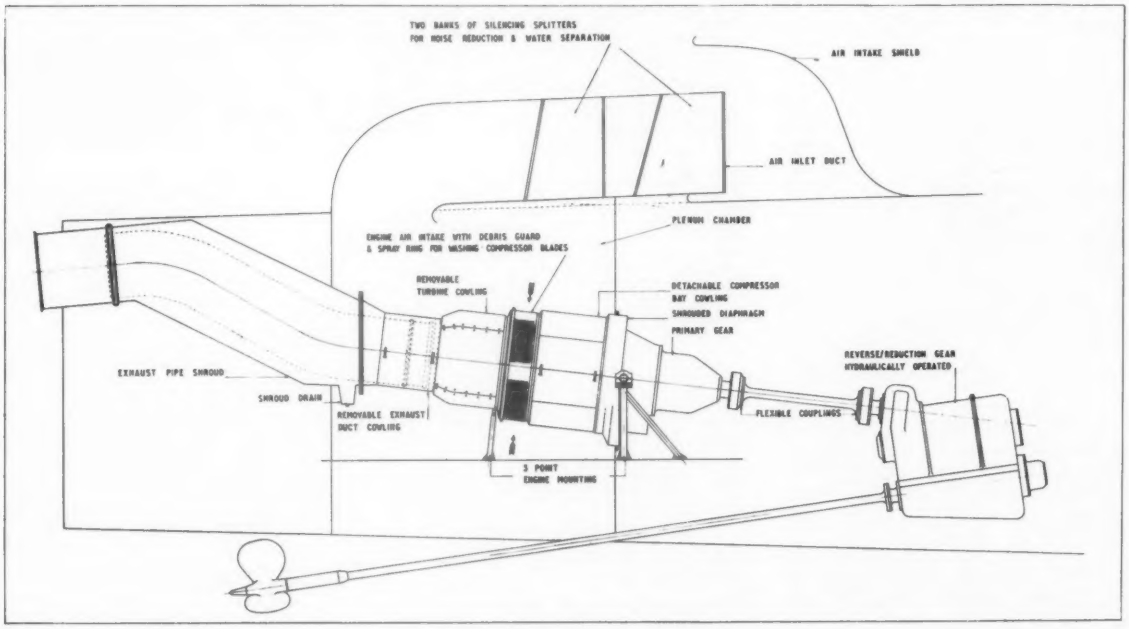
Automatic Photomicrography

A new automatic camera microscope and the first to reach this country has been delivered to Standard Telecommunication Laboratories Limited, Dowlish Ford Mills, Ilminster, Somerset. The instrument, of which there are less than 12 in the whole world, is a camera with full automatic exposure adjusting mechanism. It is suitable for visual observations as well as industrial photomicrography, and it can also be used for microprojection. The exposure mechanism is pushbutton operated, the instrument adjusting its exposure time automatically to the correct value depending on intensity of light.

Gas-turbined Patrol Boats

H.M.S. *Brave Borderer* the first of the new Brave Class Fast Patrol Boats (Medium) is powered with Proteus gas turbines, as used in the "Britannia" aircraft, but adapted for the Royal Navy by Bristol Aero Engines Limited, Filton, in association with W. H. Allen Sons & Co. Limited, Bedford, who supply the primary reduction gears and the reverse reduction gearboxes.

In addition, Rover gas turbines driving Metro-Vickers 40 kW generators are fitted to provide electrical power. No diesel machinery is fitted. Both Proteus and Rover turbines will run on pool diesel fuel. The present authorized maximum rating of the marine Proteus is 3500 shp and the maximum continuous rating 2800 shp.


TWO BANKS OF SILENCING SPLITTERS FOR NOISE REDUCTION & WATER SEPARATION
AIR INTAKE SHIELD
AIR INLET DUCT
PLENUM CHAMBER
ENGINE AIR INTAKE WITH DEBRIS GUARD & SPRAY RING FOR WASHING COMPRESSOR BLADES
REMOVABLE TURBINE COWLING
DETACHABLE COMPRESSOR BAY COWLING
SHROUDED DIAPHRAGM
PRIMARY GEAR
REVERSE/REDUCTION GEAR HYDRAULICALLY OPERATED
EXHAUST PIPE SHROUD
SHROUD DRAIN
REMOVABLE EXHAUST DUCT COWLING
FLEXIBLE COUPLINGS
3 POINT ENGINE MOUNTING

Installation of Bristol Marine Proteus gas turbine

Diesel-electric Locomotive

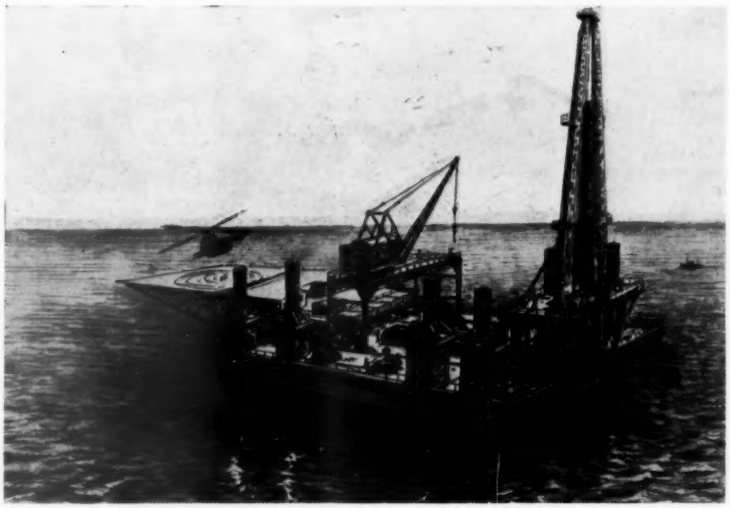
The first of the BTH series of main-line diesel-electric locomotives to be built for the British Railways Modernisation Plan has been handed over.

This locomotive, No. D.8200, is of 800 hp, has a maximum designed speed of 60 mph, and is the first to be completed of ten locomotives of this type with a Bo-Bo (two four-wheeled bogies) wheel arrangement. It has a maximum tractive effort of 37,500 lb; and the continuous rating is 20,000 lb tractive effort at 10·5 mph with a wheel diameter of 39 in.

The ten 800 hp diesel-electric main-line locomotives were ordered from BTH in November, 1955, under the initial programme for the Railway Modernisation Plan, which at that time comprised a total of 141 diesel main-line locomotives and 30 power equipments for installation in locomotives built in British Railways' works; the total number of locomotives and power units ordered is now well over 200.

These locomotives are classified as Type I (formerly known as Type A) in the British Railways' diesel range, and will be numbered D.8200–D.8209. All the ten locomotives will be allocated to Devons Road Motive Power Depot in the London Midland Region, and will work freight trains between Poplar, Temple Mills, Acton and Willesden.

TRANSPARENT GUARD.—This automatic spindle moulder is equipped with a pneumatically operated guard fabricated from Vybak DVB 229 transparent sheet, ½ in. thick. The sheet is semi-rigid and will withstand a considerable amount of mechanical abuse without shattering. It can be fabricated by conventional methods: i.e. sawing and drilling and can be formed into curved shapes by heating. Vybak DVB 229 is produced by Bakelite Limited



MARINE DRILLING PLATFORM.—A drawing of the new marine drilling platform being made for the Royal Dutch/Shell group. It will replace the one destroyed in a gale in December, 1956. Unlike the latter, the new platform will not have loose pontoons (which caused the wreck) but will be of the elevating type and will have a floating hull. It will be capable of working in water ranging from 20 to 100 ft in depth and will drill to 15,000 feet. The 140-ft mast will be mounted on slides to enable a cluster of wells to be drilled without moving the platform

Aluminium Increases Dumper Payload

A new 10 cu yd capacity ultra-heavy duty aluminium alloy dumper body, constructed by G. E. Neville and Sons Limited for Fodens Limited, is probably the most robust ever constructed in this material. The use of aluminium has cut the weight of the body to half that of the normal steel type and has enabled its carrying capacity to be increased by over 10%.

A bolted construction simplifies assembly and field repair. It was designed in co-operation with Northern Aluminium Company Limited, who also supplied the aluminium, and is basically constructed of extruded planks in Noral B51SWP alloy, formed through two 90° bends at 16 in. radius to a U shape. These planks form the floor, sides and framing of the body, and are assembled one to another by bolts passing through the front and rear flanges. The body is reinforced, externally, by the addition of extruded channels, or "top-hat" sections, also in Noral B51SWP, which conform to its outer shape and are bolted to the stiffening ribs of the plank section. Internally, there is a lining of Noral 26SWP plate, ¼ in. thick. Further protection is afforded by impact strips, running the length of the vehicle floor, which give protection to the bolts and absorb some of the heavy blows during loading. The steel body sub-frame is carried on twelve Metalastik rubber buffers.

Millionth "Meter-Miser"

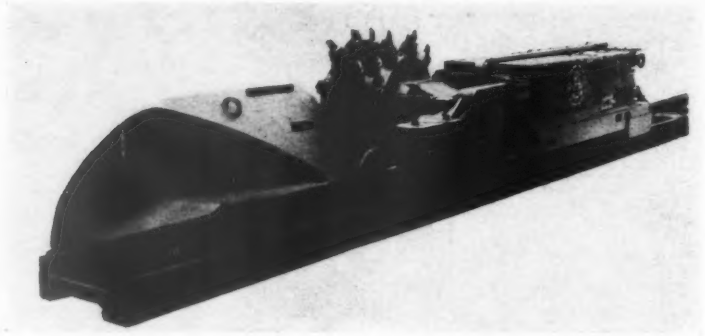
In November last the Frigidaire Division of General Motors Limited completed manufacture of their 1,000,000th 'Meter-Miser', the sealed rotary compressor unit now used in various sizes to power all their domestic and many of their commercial refrigerators. The figure has been reached in the short space of nine years and is a remarkable manufacturing achievement.

The compressor is a precision machine which consists fundamentally of an electric motor driving an eccentrically-operated rotary compressor, and is hermetically sealed in a welded steel case. It has only three moving parts—the roller, vane and eccentric shaft—all of which are machined, ground and polished to a specified tolerance of plus or minus 1/10,000th part of an inch and surface tested to seven millionths of an inch.

Mechanization in Coal Mines

The past decade has witnessed a considerable expansion in mechanized methods of mining and bringing the product to the surface. Machines which are being increasingly used include hydraulic coal bursters, coal cutters and loaders, shuttle cars, conveyor belts, locomotives, and the system of Koepe winding for shaft transport. Progress underground is also facilitated by the use of light alloy cars and roof supports.

THE winning of coal from underground seams has long been associated with hard manual labour carried out under hazardous conditions, with inadequate light and air supply. At the dawn of the present century, coal cutting machines, conveyor belts, and locomotives, had reached the experimental stage, but underground were still regarded as curiosities; the coal being cut for the main part by the miner's pick, assisted by frequent shot-firing, while pit tubs were man-handled to main roadways, where ponies took over. So far as Britain is concerned, mechanization of the process of moving coal out of the seam to the pit-head was not widely used until the National Coal Board took over the running of British mines, when the job gradually became more mechanical than manual. As a consequence the modern miner is more skilled in the handling of machines peculiar to his industry than he is in striking the seam at the right spot with his hand-pick. While the amount of product produced in relation to the expenditure of human energy is now much greater than formerly, the quality of the product has been reduced. This latter feature is due to several factors. Unlike the miner, the machine is unable to discriminate between coal and dirt; the power applied to the coal face breaks down the coal to small pieces and dust; poor seams which some years ago would be written-off as unworkable are now being worked.



Anderson, Boyes & Co. Limited.

Fig. 1. Anderton shearer-loader, a combination of longwall cutter and loader.

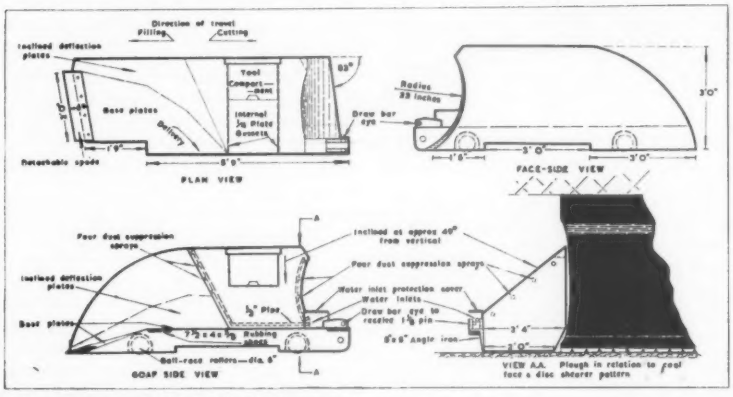
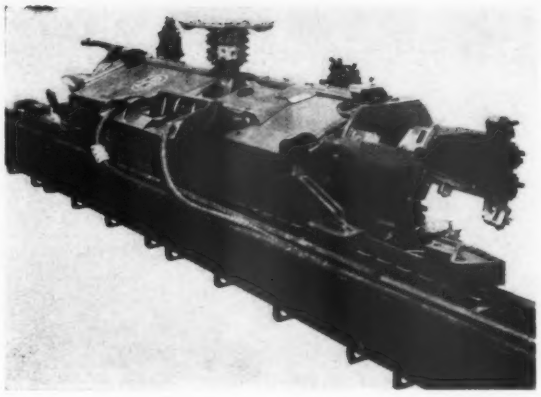


Fig. 2. Constructional details of the disc-shearer unit and plough of the Anderton shearer-loader.

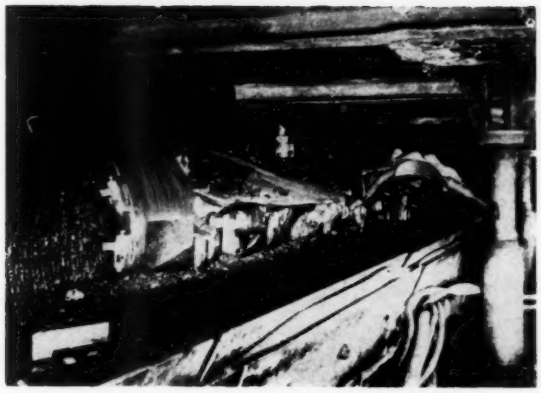
Coal burster

The hydraulic coal burster is a device which has been evolved partly to eliminate shot-firing and it represents an improvement on this time-honoured method, for it cannot ignite gas or dust, and since there is no blast, there is no damage to miners or equipment. Moreover, the action of the burster does not shake the roof or disturb roof supports, while the miners do not have to be withdrawn from their workplace to be confronted a few minutes later with a new set of conditions resulting from blasting having taken place. Because the burster is silent in operation, the miner can see and hear any movement of roof and take the necessary precautions. The hydraulic bursting machine is suitable for coal and other minerals of similar density. It consists of a round stainless steel hollow bar, to be inserted in a hole drilled in the coal face, the bar being chambered at intervals to accommodate telescopic pistons. Suitable ports are bored in the bar to convey water to the underside of the pistons, which latter are thus forced out at high pressure into the block of coal. Each piston is prevented from being forced completely out of the bar by stops which engage with projections on the piston when it has travelled the full working distance. The high pressure flexible hose through which the water is conveyed is connected to the bursting bars by means of a quick make-and-break coupling, the other end of the hose being attached to a hydraulic pump. This is a vertical three-plunger type, motor-driven unit, the pump box acting as



Anderson Boyes & Co. Limited.

Fig. 3. Longwall trepanner, cuts and loads in one operation.



Anderson, Boyes & Co. Limited.

Fig. 4. Double ended trepanner in operation underground.

a reservoir for water, which latter contains a small quantity of oil to act as a lubricant in the hydraulic system. A Wigan company is now making these hydraulic bursters in several sizes, the choice depending on the density of the coal to be broken down; the diameter and length of the bar, and the number of pistons, vary with conditions.

The average time taken to complete a burst after the bar has been inserted in the wall of coal is 25 sec. Since the diameter of the holes to be drilled in the coal is somewhat larger than those required for shot-firing, drills have been evolved to produce holes as quickly as can be done for shot-firing. An average size hole has a diameter of $3\frac{1}{4}$ in. and this takes a burster bar of $2\frac{3}{4}$ in dia. Valve gear on the pump unit makes it possible to operate several burster bars automatically from the pump, and about 20 bursts per hour can be achieved with each bar.

Cutters and loaders

While coal cutting machines have been in use for over half a century, the units in use today bear little resemblance to those doing duty in 1900. These old machines could be applied only to relatively soft coals, while today the denser varieties can be successfully cut. Considerable success under difficult mining conditions has been achieved with the Anderton shearer-loader, Fig. 1, which may well prove to be the most useful in longwall working of coal seams. The machine has the advantage that it is relatively cheap and easy to make, and it is already being manufactured by a number of engineering concerns. In Britain over 50 of these machines are already in use. The machine consists essentially of a standard longwall coal cutter on which the normal cutting end has been replaced by a gearbox carrying a projecting horizontal shaft. This shaft carries a number of shearing discs, the number being varied to suit the hardness of the seam and thickness of web to be taken. This slice is normally between 16 in. and 32 in. thick. The shearing discs are about 36 in. dia and on the periphery of each disc are six cutter-pick boxes into which tungsten carbide-tipped tools are inserted. These tool bits have a tip speed of about 700 ft/min, and as the machine moves along the coal face, the cutting bits penetrate into the coal to a predetermined depth. Power is obtained from flameproof electric motors operating through gearing to give a range of speeds to suit specific conditions. The machine is mounted on a flexible armoured conveyor, and on the cutting run, the plough, which is attached immediately behind the discs, deflects the dislodged coal on to a chain conveyor. The steel plough is double-faced and on the return run any loose coal on the floor which may have escaped the plough on its outward run is loaded. The diagrams, Fig. 2, give some constructional details of the disc-shearer plough unit. With a coal face or "longwall" of 150 yards, the complete operation of cutting, loading and picking up on the return journey can be completed in less than 2 hr.

Trepanners

Another type of cutter and loader is the trepanning machine, Figs. 3 and 4, some of which are double-ended, enabling them to operate on the outward and inward run without turning round. The essential components of the machine are the cutting heads, electric motor, haulage gear case, a shearer bar, roof-cutting disc and a control panel. In the double-ended unit, each head carries a 35 in. dia trepanning wheel, a floor cutting jib, and a back-shearing jib. The trepanning wheel has two arms, each carrying eight cutter-picks, which on revolving at slow speed, cut out a thin annulus causing a core of coal to form inside the wheel. This core breaks off either naturally in the case of soft coal, or by the action of breaker picks for harder coals, and is swept out sideways by the arms, falling on a conveyor. The floor-cutting jib is arranged to make a level floor at the base of the machine. Its length can be varied to suit the particular seam being worked, and it may be moved round and parked under the trepanning wheel when the machine is being moved from one working face to another. Material removed by the floor-cutting jib is loaded on the conveyor by paddles fixed to the back of the trepanning wheel. The shearing jib is mounted on the side of the gear head, and is of the thin kerf type with adjustable working height, operated hydraulically to suit the thickness of the seam. Mounted behind the left-hand gear head is a 70 hp motor, controlled by an off/on switch on the control panel. There is a separate reversing switch and also an emergency stop switch; reversing is necessary at the end of the outward run, and also when the core being collected by the wheel is unduly hard, such as when rock is unexpectedly encountered. Hydraulic power is employed to actuate the conveyor

Mavor & Coulson Limited.

Fig. 5. Electrically-driven coal loading machine, for loading loose coal on to belts or mine cars

Mavor & Coulson Limited.

Fig. 6. A five-pulley idler carrying a 36 in. belt up a gradient of 1 in 3½

chain driving sprocket mounted on the conveyor side of the gear case.

Above the gear case are fitted the shearer bar and roof-cutting disc. In places where the coal leaves the roof without difficulty, the disc is removed and replaced by the shearer bar carrying "mushroom" picks. The column supporting the roofing gear has a hydraulic vertical adjustment which can be operated when needed when the machine is moving. This vertical adjustment comes into operation when the distance between floor and roof is not constant. Mounted on the front of the gear case are the main machine controls, where, by means of a canopy, they are carried over the conveyor to within easy reach of the operator. The canopy allows moderately-sized lumps of coal to pass beneath, but will break up any large pieces which might be dangerous. This canopy also serves to protect the trailing cable and carry it across to the free side of the conveyor. The trepanning machine cuts and loads in one operation on the principle of continuous mining by narrow webs. It cuts and loads the coal in both directions of travel, by attacking the coal on the buttock and discharging it into the armoured conveyor. This latter feature eliminates the need for props between the conveyor and the coal face. The continuous haulage operation is achieved by means of a chain, anchored at each end of the face conveyor and threaded round two idler sprockets and one driving sprocket on the side of the machine. In the case of the double-ended trepanner, the chain has a pitch of 1·8 in. and is made from ½ in. alloy steel; the total length of the machine is 15 ft between the picks on each trepanning wheel. As the trepanner is a relatively new machine, modifications will probably be made later, but at present it is arranged to work in a minimum seam section of 39 in. and to take a depth of web approximately 27 in. There are several modifications of coal cutters and loaders, some being designed to operate in very narrow seams and are built low accordingly; others have additional equipment for dealing with high coal overhead and which cannot be reached with the standard equipment.

Where the cutting machine does not incorporate a loading unit, a separate mechanical loader, Fig. 5, may be used. This machine will raise coal from floor level to that of a conveyor belt or pit tub, etc., by the use of mechanical gathering arms at near floor level and a conveyor chain. The two gathering arms, seen in the foreground of the inclined ramp which rests on the floor, are given an outward and inward swinging motion, the power being derived from a 50 hp motor, and the coal loaded may be as much as 5 tons/min. The width swept by the arms is 5 ft 9 in. and the width of the conveyor is 21 in.

Shuttle cars

The shuttle car has been specially designed for use in trackless mining and by its use the development costs of a mine can be reduced because no railways are necessary. In some mines the shuttle car operates between the coal face and other forms of transport, feeding a conveyor belt or tubs. It consists essentially of a low-built, rubber-tyred truck, operated by a motor and electric battery, and in some cases it embodies a mechanical loader. Thus the shuttle car can pick up coal at the working faces and transport it to pit-bottom for discharge into skip hoppers where skip winding is in use, or it may discharge at some intermediate point to other forms of transport. The car is provided with two separate steering systems, one hydraulic and one mechanical. In the event of failure of the hydraulic system, the operator still has complete manual control of the machine. Due to a long wheel base, it remains steady when passing over the rough floor of the mine. This inherent stability enables the car to operate with less roof clearances, since the ends of the car do not tend to rise appreciably. A modern transmission development has been incorporated, the no-slip differential, which permits the outer wheels to rotate faster than the inner wheels when turning a corner. In the shuttle car the wheels are positively prevented from spinning, and if one wheel runs into a mud hole, the no-slip device automatically transmits full driving power to the opposed wheel; thus the unit cannot bog down in bad ground unless all four wheels stick simultaneously. The loading device, when used, consists of a two-speed conveyor; the high speed being used when loading from a substantial heap of coal, or discharging into tubs or hoppers, the low speed for picking up slowly from another slow-feed source, or discharging on to conveyor belts.

Conveyor belts

Belt conveyors are now applied extensively underground and in a few cases they form the means of bringing the coal to the surface, via an inclined shaft instead of a vertical one. The present tendency is to

substitute non-inflammable material for the rubberized fabric which was previously used, and so reduce the fire hazard in gassy mines. While the initial cost of a belt conveyor is relatively large, experience shows that it is not the tonnage carried, but other factors which determine the life of the belt. Damage is of far greater importance in determining how long a belt will last than the number of tons carried, and damage is reduced to a minimum by careful maintenance of the troughing idlers. These are the rollers over which the belt passes when carrying its load and these impart the trough-like shape to the otherwise flat belt. To get this contour, use is made of three or five idler rollers, the latter number being used for broad belts; with three rollers, the centre one is horizontal while the two outer ones are inclined. With five rollers, generally both pairs of outer ones are inclined and these trough the belt approximately to the arc of a circle. Any misalignment of rollers will obviously stress the loaded belt when it passes those points, and maintenance routine consists mainly of inspecting the rollers for misalignment and keeping a grease supply on the enclosed ball bearings.

At the point where the belt receives its load, it can be given additional support by the use of double-cushion idlers, and these preserve the belt in two ways, for the rollers are covered with resilient material and their base plate is suspended on similar material. The idlers which carry the return portion of the belt have merely to carry the weight of the empty belt and each idler in this case consists of a simple horizontal roller running in ball bearings. In the majority of coal mines the pit bottom does not represent the lowest working point in the mine, which means that often some means of power transport has to be employed to bring the coal to pit bottom level. Hitherto this has been done by the use of haulage ropes, powered either by compressed air or electricity. In recent years, however, there is a tendency to replace the haulage rope with a conveyor belt and some of the latter now operate on quite appreciable gradients. A typical example of this is seen in Fig. 6, showing a five-pulley idler carrying a 36 in. belt up a gradient of 1 in 3½.

Whether running on a gradient or not, a belt must be tight enough to preserve the troughed form, to keep

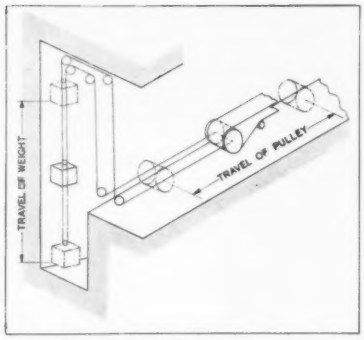


Fig. 7. Method of applying tension to a long belt conveying uphill

"Mine & Quarry Engineering."

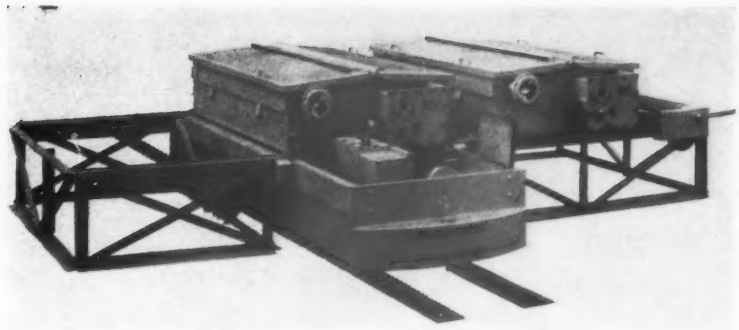
Fig. 8. A 2½ ton diesel locomotive, fitted with exhaust quencher and low type cab

slack from gathering, and to impart a grip to the driving drum. Tension is applied by a take-up, consisting of a sliding pulley and the means for maintaining tension on the pulley. This pulley is sometimes the tail pulley of the conveyor, but more generally a bend pulley round which a loop of the bottom belt passes. There are various methods of applying tension to the take-up pulley but in the case of long belts the gravity take-up, Fig. 7, is often used especially for a long belt conveying uphill. In this arrangement, as the weight of coal on the belt varies, so does the stretch of the belt. Slack is kept from gathering by the weight which pulls the tail pulley along guides. Initial tension on a new belt is applied through the medium of a loop take-up, which takes up most of the stretch in the belt; the gravity take-up has, therefore, only to make the final adjustments needed from day to day working.

Locomotives

An underground locomotive forms an economical haulage unit when the layout of the mine permits fairly level main haulage ways. These units may be divided broadly into two basic types, electric battery and diesel. The electric unit is considered to be the safer where there is danger of gas, but much progress has been made with diesel locomotives and many of the latest models of these are flameproof, carrying the Buxton certificate. The other drawback formerly associated with diesel engines underground, contamination of the limited air supply with exhaust gases, has been eliminated with exhaust quenchers which are now fitted to most types. Generally speaking, bulk for bulk, the greater power is obtainable from diesel locomotives. Against this, the electric model is considered to require less routine maintenance. A typical electric locomotive weighing 13 tons has two motors, the total one-hour rating at 200 volts being 64 hp, and the speed about 8 mph. A diesel unit of similar power has a weight of approximately 9 tons. The smaller diesels have two cylinders only and employ direct injection, engine speed being controlled by a mechanical governor from 350 rpm to a maximum of 1800 rpm. A gear box provides two speeds, enabling the engine, by the use of a reverse lever, to push as well as pull. In wet mines the locomotive is provided with a sander to obtain a good grip on the rails. Larger models, which may be of 100 hp, have three cylinders, and three speeds forward and a reverse. A typical 2½ ton, 28 hp diesel locomotive is depicted at work in Fig. 8.

Recent years have seen the application of the principle of transmitting hydraulically the diesel engine power to the wheels of a mine locomotive. The use of hydraulic transmission makes for longer engine life because there are no mechanical connexions between engine and wheels; thus any undue stresses on the latter are not transmitted to the engine. Due to the absence of a clutch the locomotive may be accelerated more quickly; this acceleration is smooth and stepless since no mechanical linkage is involved in the transmission. These features are obtained by the use of several distinct hydraulic fluid circuits, and each of these has a specific operating speed. Depending on the power required from the locomotive at a given moment, the hydraulic fluid—oil—is transferred to an appropriate circuit without the necessity for gear changing or the operation of a clutch. This movement of oil from one circuit to



William Neill & Son (St. Helens) Limited.

Fig. 9. Battery changing station for small mine locomotives. A rack and pinion carriage replaces an exhausted battery with a newly-charged one.

another is operated by the use of the mechanical governor which, in turn, operates in accordance with the speed of the wheels. Hydraulic power is obtained by a pump operating off the diesel engine; this pump also circulates the oil through a cooler to obtain maximum transmission conditions.

Battery locomotives are popular as they require a minimum of maintenance, are easy to learn to drive and handle. A feature of the locomotives employed for main haulage and man-riding is the arrangement of the traction motors and their reduction gearing. By the use of a double reduction gear and the introduction of an idler into the gear train, the motor need not be confined within the space between the road wheels but may take advantage of the full locomotive width. This enables large motors to be used on narrow rail gauges, while maintaining the diameter of the wheels at a minimum; small diameter wheels permit of the installation of large-capacity batteries within the available headroom. In the majority of mines as one gets further away from the pit bottom the amount of headroom tends to get less and less, for more care is given to the construction of main roadways since these will be in existence long after a particular byway is worked out. It follows that if locomotives are to be employed in by-ways, feeding the larger locomotives on the main haulageways, the by-way units must be built low. One such locomotive is no more than 4 ft 1 in. high and is seen in Fig. 9, in its small battery-changing station. Replacing a spent battery with a newly-charged one is done by a simple mechanical device involving a rack and pinion; by turning the handle at the side of the framework the spent battery is traversed off the locomotive and simultaneously the new one is brought on the locomotive. Each alternate change requires that the batteries be moved in the opposite direction, which is done by simply reversing the handcrank. The small locomotive illustrated has two traction motors, each of 17½ hp, making a power unit of 35 hp.

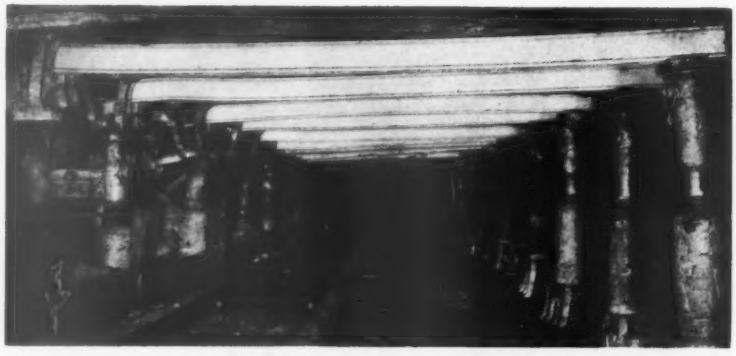
"Colliery Engineering".

Fig. 10. Examples of aluminium-bodied mine cars.

Power requirements for a given haulage road are considerably reduced by the use of aluminium alloy tubs and cars, since the deadweight for a specific mineral load is less. Where a locomotive is already in use hauling steel tubs or cars, the substitution of light alloy for steel enables the number of units in a train to be increased without increasing the load on the locomotive. The complete redesign in aluminium alloy of standard steel cars can triple the load/tare ratio, for example, from 2:1 to 6:1; while the more common practice of replacing the steel body with one of light alloy, and still retaining the existing steel underframe, can increase the load/tare ratio 3:1. Examples of aluminium-bodied mine cars are seen in Fig. 10.

Roof supports

During the past few years increasing use has been made of aluminium alloys in the form of roof supports. Compared with timber or steel, the advantages of light metal are, briefly, that it is stronger than timber and is more easily placed in position and can be used repeatedly on different sites. Steel is very efficient as a roof support but its weight often makes it difficult to set properly in the confined space underground; it is approximately twice the weight of light alloy. The alloys used for roof supports are based on aluminium, never on magnesium due to the tendency of this to flash when it



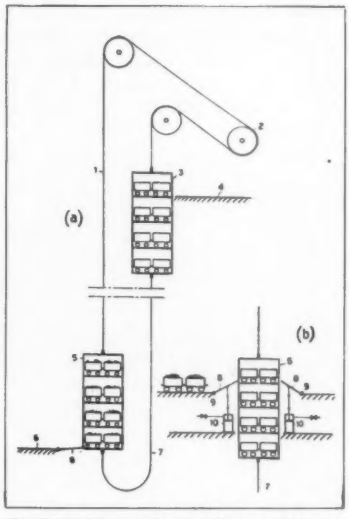
Northern Aluminium Company Limited.

Fig. 11. An installation of Dowty slide bars cast in Noral 125W alloy, being used with 3½ in. by 3½ in. beams extruded in Noral 58SM alloy.

breaks, and the alloys invariably contain small proportions of copper, silicon, manganese and sometimes iron. In tests carried out on a roof support alloy, extruded to form a double H-beam, which was then cut up into sections to form typical beam lengths for mines, one of the resulting beams was tested in bending when supported at 10 ft span and loaded equally at the quarter span points. Under a load of 9·5 tons, the beam, which had dimensions of 4 in. by 6 in., deflected 10·5 in. at mid-span, recovering 2·5 in. when unloaded. In three subsequent tests in reverse bending

it carried higher loads with less deflexion. Such tests show that the beams are suitable for use underground.

The so-called slide bar head, Fig. 11, is constructed in cast alloy. It is a form of cantilever support consisting of a special type of prop head through which a beam can be passed and wedged up to the roof. In using these, the head is first preloaded against the roof and is allowed to remain in that position until the prop is finally moved forward, so that continuous local support of the roof is obtained. This type of support is much used near the coal face, for it extends to support the roof where men and machines are operating without the necessity for vertical props near the face. The majority of cutting and loading machines could not operate if it became necessary to support the beams at the end nearest the coal face. Light metal props are also in use as supports for the cantilevered ends of roof bars when for some reason or other it is desired



The British Thomson-Houston Company Limited.

Fig. 12. Typical Koepe winding layout, showing cage loading arrangements.

to give extra support to the roof. These props are often of the screw-jack type, weighing only 20 lb., but they support about 26 tons before failing.

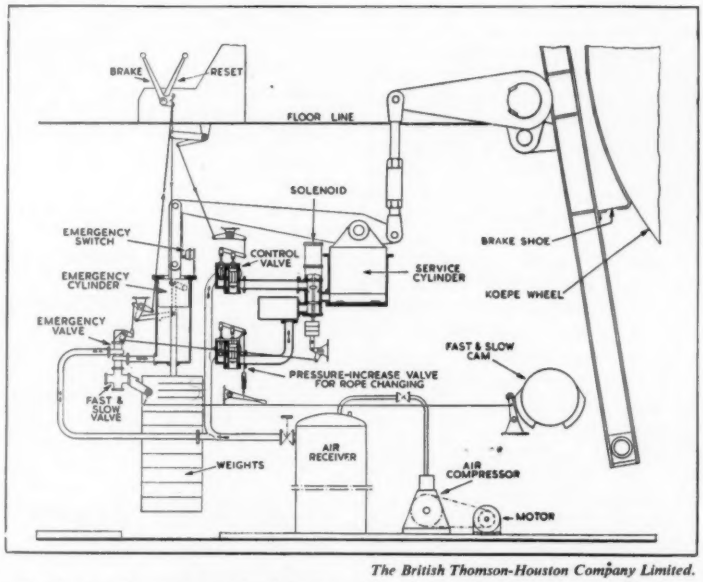
Koepe winding

In ordinary types of winding, the heavy masses of the drums necessary for the long ropes which have to be accommodated on them, and the coiling lengths which are dependent on the length and diameter of the winding ropes, demand great accelerating and braking forces, and also large engine houses. These difficulties have led in many cases, particularly on the Continent, to the adoption of the Koepe winding system, which does not make use of a winding drum, so that no great

National Coal Board.

Fig. 13. Koepe wheel and driving motor at Snowdown Colliery. Kent.

length of rope is ever required to be housed on a drum, from which it must be continually unwound and rewound. This process gives relatively short rope life due to the pressure of one coil of rope on the one underneath, for the weight on the end of a loaded rope may be 30 tons or more. Koepe winding is less expensive than drum winding due to the fact that Koepe wheel which propels the rope by friction is much smaller than that of a drum for the same winding capacity. This reduction in the inertia of the revolving masses and the fact that the pay-load is the only out-of-balance load—due to a balance rope being used—reduces the amount of winding power necessary. Stresses on the rope are reduced owing to the absence of keps which are pushed out to support the cage when decking to bring the cage rails in line with those at pit-head and pit-bottom respectively. Decking with a Koepe installation is done without the use of keps and the cage is always supported fully by the rope. Due to rope stretch with varying loads, decking is done by the use of hinged flaps carrying a short length of track and which can rise or fall to meet the deck level, one end of the flap being fixed to the permanent way. Keps used with a Koepe wheel would cause rope slip on the wheel, since the rope is not fixed to the wheel. The diagram, Fig. 12, outlines a typical Koepe arrangement, in which (1) is the winding rope, (2) is the Koepe wheel, (3 and



The British Thomson-Houston Company Limited.

Fig. 14. Diagrammatic arrangement of brake-control gear for a Koepe winder.

5) are cages, (4) pithead, (6) pit-bottom, (7) balance rope, which weighs the same as the winding rope, and (8) is a hinged flap. In (b) an alternative arrangement is shown in which the decks of the bottom cage can be forced down by the flaps when operated by the power cylinders (10).

Since the rope is not attached to the Koepe wheel and the system operates by friction between rope and wheel tread, the latter must possess a high coefficient of friction.

Much experimental work has been carried out on the subject of the most suitable material for the treads of a Koepe wheel, but in spite of this, elm wood still remains popular so far as Britain is concerned. Abroad the present tendency is to replace elm wood with laminated fibrous materials of a similar nature to that of certain brake linings, and so obtain a still higher coefficient of friction.

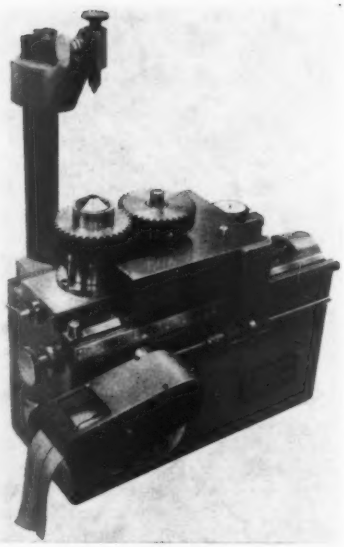
The oldest Koepe installation in Britain is at Murton Colliery, Durham, and this has been successfully operated for many years. Several others have been installed within the past few years. One of these is at Snowdown Colliery, Kent, Fig. 13, which has been designed to raise 243 tons of coal per hour from a depth of 1000 yards, with a payload of 7½ tons of coal in three mine cars, there being one car per deck in a 3-deck cage. The Koepe wheel uses elm wood treads, and is 23 ft dia. Two rope grooves have been made in the wood blocks, and when one becomes worn, the rope may be run into the other one. The winder motor is direct-coupled to the wheel and is rated at 2580 hp, the full speed being 41·5 rpm, giving a rope speed of 3000 ft/min. Among the problems considered in planning the reconstruction of Bradford Colliery, Manchester, was the fact that not only had the winder to raise coal from a depth of 3822 ft, but during the period of reconstruction it would be dealing with two intermediate seams at lesser depths. To meet these different winding levels it was decided to use Koepe winding, and an order was placed with the Metropolitan-Vickers Electrical Company Limited, the mechanical parts being built by Fraser & Chalmers Engineering Works, acting as sub-contractors to the other company. The Koepe wheel, which is 24 ft dia, is driven by two motors having a continuous r.m.s. rating of 3720 hp, through 8·68:1 single reduction gears. Skips instead of cages are used, each skip holding 12 tons of coal, and the output is estimated to be 400 tons/hour from each of the three seams.

It is necessary to couple high-speed winding with a good brake system, and the diagram, Fig. 14, shows a type of brake engine often employed for Koepe wheels. It is a short-stroke type of brake but has, in addition, fast and slow braking features. This brake is primarily air-pressure applied, braking being obtained by the admission of air pressure to the short stroke service cylinder, which is for normal operation. In the event of failure of the air pressure the brake is applied by the falling of weights, and in this case the top of the service cylinder becomes the fulcrum for the operating lever. In emergency braking, tripping of a solenoid first admits air to the service cylinder; air for this purpose being stored in the receiver between the pressure-increase valve and the service cylinder. This air is at reduced pressure, so that emergency braking is applied in such a way that it cannot produce rope slip on the Koepe wheel. Following the admission of air to the service cylinder, air is released from the cylinder supporting the brake weights, so that weight-applied braking follows air-pressure-applied braking. The rate of follow-up of the weight-applied brake is controlled by a fast and slow cam in the normal manner. A further device is fitted in the form of a link between the control valve and the pressure-increase valve. This device enables the driver to increase pressure during emergency braking when necessary to do so. Under these circumstances it may be possible to produce rope slip, but the arrangement is much in use on the Continent. The pressure-increase valve can also be put into the maximum emergency braking position during rope-changing when out-of-balance loads can be much greater. This means that there is always sufficient emergency braking torque available to stop the Koepe wheel under the worst conditions of rope changing.

Gear Roll Tester with Graphic Recorder

A simple, rapid and positive means of checking concentricity, tooth contact, centre distance and tooth thickness of a wide range of gears is provided by the David Brown No. 9R gear roll tester. The standard instrument accommodates spur and helical gears up to 9 in. centres and easily interchangeable attachments are available for shaft gears, bevel gears and worm gears.

Gears undergoing test are driven by a variable speed motor, the same power unit driving the recording head which automatically gives a full and permanent graph. Errors are recorded on a dial indicator which is in contact with a sensitive carriage loaded by adjustable spring pressure. The dial is graduated to 0·0005 in. as standard, but 0·001 in. graduation can be provided if required. Actual gear centre distances are read directly from the vernier scale at the front of the instrument.



The standard David Brown No. 9R gear roll testing instrument with attachment for shaft gears

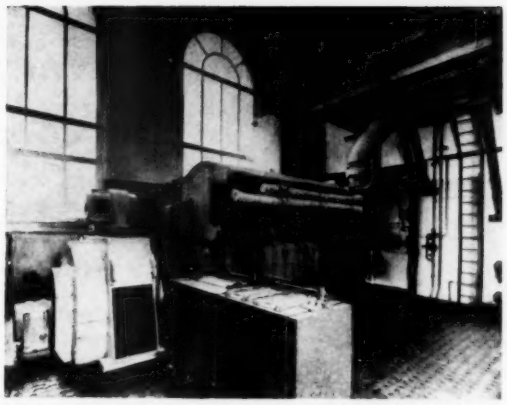
With an actual range of 0·008 in., the graphic recorder unit gives a magnification of 250 to 1; thus an actual error of 0·0002 in., is shown as 0·05 on the graph paper. The drive is arranged so that one revolution of the gear under test produces a graphical recording 12 in. long. The variable speed motor allows the gear speed to range from ¾ to 2 rpm, the feed mechanism ensuring a positive relationship between gear and graph paper.

The attachment for shaft gears consisting of a V section pillar, locating on the bed and carrying an adjustable top centre is shown fitted in the illustration. Units for bevel and worm gears are separately mounted on the sensitive carriage. Backlash in a pair of gears may be calculated by noting the difference between the working centre distance and the centre distance when the gears are in metal-to-metal contact.

Of extremely rigid construction throughout, the instrument is designed and built by the Tool Division of David Brown Industries Limited, Huddersfield, to ensure that the initial high degree of accuracy is maintained in use.

Evaporative Cooling by Diesel

A diesel generating plant which is capable not only of supplying mill power demands at a low running cost, but also applies waste heat to the provision of low pressure steam and hot water for space heating and process requirements.

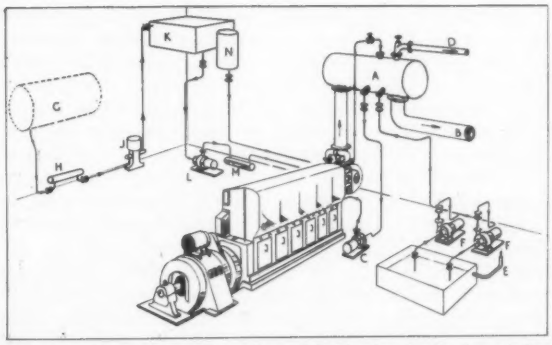


Diesel generator which supplies mill power demands. By employing evaporative cooling the engine is run on heavy fuel and waste heat is used for space and process heating

FOR many years evaporative cooling has been considered in conjunction with larger types of diesel engines and considerable success has been obtained in America, but it is thought that an installation at the flax spinning mill of J. & T. M. Greaves, at Belfast, is unique in that not only is evaporative cooling employed but the engine is running successfully and continuously on 3500 seconds viscosity fuel.

The engine is a Mirrlees KSS. 6-cylinder, totally enclosed, 4-stroke, airless injection, cold starting, turbo-charged heavy oil engine, developing 1470 bhp and fitted with a Brown Boveri supercharger and inter-cooler, directly coupled to a Brush 1030 kW alternator of 1287·5 kVA at 0·8 power factor, 500 volts, 50 cycles, 3 phase, 4 wire.

The engine is arranged for evaporative cooling and the heat is dissipated through a waste heat boiler. The boiler is a Spanner Swirlyflo smoke tube, 4 ft 6 in. dia × 7 ft long, and is designed for a maximum evaporation rate of 4000 lb/hr calculated on 2000 lb/hr from feed water at 120° F, when passing 17,600 lb of exhaust gas per hour at 850° F with the engine on full load, and 2000 lb/hr produced by the heat dissipation from the circulating water. The cooling water is arranged on a closed circuit passing from the engine through the exhaust gas boiler and returning to the engine via an electrically driven centrifugal pump, at a rate of 24,000 gal/hr. The temperature of the water entering the jackets is 228° F and there is an 8° temperature rise through the engine, giving a circulating water temperature to the exhaust gas boiler of 236° F at full load.



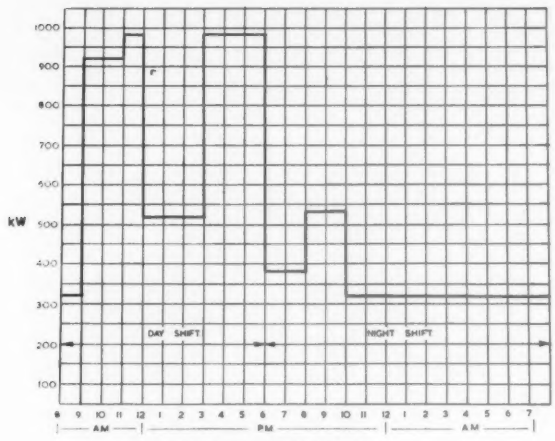
Plant layout showing evaporative cooling and fuel heating circuits. A, waste heat boiler; B, exhaust to chimney; C, engine jacket water pump; D, steam to factory; E, condensate return from factory; F, boiler make up pumps; G, heavy fuel storage tank; H, fuel heater; J, fuel purifier; K, heavy oil daily service tank; L, heavy oil circulating pump; M, fuel heater; N, light oil daily service tank

It has been calculated that with the engine on full load there would be an 8° temperature difference across the engine inlet to outlet. Based on 24,000 gal of water in circulation this would give approximately 2,000,000 B.Th.U., i.e. 2000 lb of steam per hour at 4 to 5 psi.

In addition to passing the circulating water through the exhaust gas boiler, the engine exhaust gas is passed through the boiler at an inlet temperature of approximately 850° F. Theoretically, providing the exhaust gas temperature can be reduced to a final outlet of 220° F, a dissipation on full load of 3,000,000 B.Th.U./hr is available. In this instance the outlet temperature of the gas from the boiler is approximately 600° F. The exhaust gases are then led from the boiler to the main flue of two existing Lancashire boilers and in series passed through a feed water economizer, process water economizer and air heater for a driving loft, before passing to the atmosphere via the main stack at about 200° F.

In addition to absorbing the heat dissipated to the engine main circulating water and the heat recoverable from the exhaust gases, there is a separate circulating water circuit which supplies the turbo-charger intercooler and the lubricating oil cooler in series. The heat absorbed in this circuit is being used in the mill, either for heating or process hot water.

The engine is designed to run on heavy fuel with a starting up period and a closing down period of approximately 30 min, during which the engine, prior to changing over to the heavy fuel, will run on Class A diesel fuel. The heavy fuel being used on this particular installation is commonly termed boiler fuel, with a viscosity of 3500 seconds Redwood 1 at 100° F, with a gross calorific value of 18,350 B.Th.U. per lb. The heavy fuel oil is drawn from the main storage tanks at a temperature of 90° F to 100° F, and passed through a 5 kW/hr thermostatically controlled electric heater, where its temperature is raised to 220° F prior to centrifuging. From the centrifuge the fuel is pumped to a daily service tank in the engine room of 800 gal capacity, where its temperature is maintained at 190° F by a thermostatically controlled 16 kW/hr immersion heater. Fuel from the daily service tank is then drawn off by gravity feed to a small circulating



Load cycle for 24 hr period

pump. This pump is on a closed circuit and the fuel passes through a 3 kW/hr thermostatically controlled heater where its temperature is raised to 235° F. The main fuel pumps are fed from this closed circuit and due to the fact that fuel oil is in circulation the temperature remains constant at 235° F throughout the circuit.

Prior to shutting down it is essential to clear the entire circuit of heavy fuel oil as 3500 seconds fuel becomes very viscous at normal temperatures, which would prevent starting the engine or, if the circuit were not completely clear, give rise to difficulty in starting. However, providing the engine is run for about 30 min on normal Class A diesel fuel, this is a sufficient length of time to ensure that the heavy fuel oil is completely cleared. The changeover from heavy fuel to light diesel fuel is a simple operation and effected by means of a 3-way cock.

The following costing is based on the load cycle shown in the accompanying diagram.

Fuel	0·71
Lubricating oil	0·08
Wages (engine drivers)	0·086
Spares and maintenance	0·1
Auxiliary power	0·024
Total	1·000d.
Credit for heat recovered based on 6/9d. Per 1,000,000 B.Th.U./hr.	0·296
	0·704d.

The plant heat balance based on gross calorific value of 18,350 B.Th.U./lb is as follows:

Heat to fuel		100%
„ „ work/kW	35·33	
„ „ steam	29·1	
„ „ feed water economizer ...	11·8	
„ „ process „ „ ...	4·45	
„ „ air heater	1·72	
„ „ space heating	8·93	
Heat loss radiation and flue ...	8·67	
	100·00%	100%
Gross heat recovered	91·33%	
Allowance for auxiliaries, heaters, pumps, etc.	3·33%	
Net overall thermal efficiency ...	88·00%	

Mobile Workshops for Oilfields

Said to be the first of their kind to be made in the United Kingdom, two trucks, each a mobile workshop, with radio cabin and aerial, have been shipped recently to Compania Shell de Venezuela for use by oil-field workers. Mounted on Commer 3-ton LWB chassis, the bodies, which cost about £1250 each, were made to the design of Shell engineers by O. G. Lywood Limited, Hayes, Middlesex.

Each truck is divided into two compartments. The forward one, 4 ft 8 in. long, 6 ft 6 in. wide, is fitted with a sliding door and is provided with foam rubber seating and handrail for the use of the crew and a steel table and loose chair for the radio operator. A light alloy aerial mast is fixed to the outside corner of the truck. The rear compartment, 8 ft 8 in. long and 6 ft 6 in. wide, is boarded on the sides to a height of 4 ft 6 in., with an open space above to roof height. Inside is a switchgear box and a large toolbox, the latter bolted to the floor; two more toolboxes are slung beneath the sub-frame, also a gasoline tank, for cleaning purposes.

Facilities for the carriage of long lengths of pipe are provided by a ducting at floor level extending through the partition to an access flap in the front bulkhead. A 6 in. engineers vice on a sliding draw-out support allows the manipulation of long pipes across the rear of the body. Two searchlights are mounted on the catwalk at the rear of the truck. Power for hand tools and handlamps is obtained from two 25 V and 50 V sockets on the transformer which in turn is connected to the mains supply by a lead, 30 metres long, via the switch box.

The body is fabricated from 14 B.G. steel channel sections electrically welded at intersections. Sides, roof and ends are completely prepanelled before assembly and finally bolted together. The 4 in. rolled steel channel sub-frame is completely floored with $\frac{1}{16}$ in. mild steel chequer plate. The roof of the forward compartment is insulated with 2 in. of Fibreglass and ventilated with a $7\frac{1}{2}$ in. Vent Axia fan.

Three Ounce Electric Soldering Iron

Of entirely new design, the Wolf No. 92, a 25 W lightweight model soldering iron has been developed by Wolf Electric Tools Limited, Pioneer Works, Hanger Lane, London W5, to meet the requirements of continuous small radio assembly and instrument work. The element wound on flat mica strip and folded with an interposing mica insulating piece is encased in mica and enclosed within a rectangular section steel casing.

The dull, nickel plated copper bit is designed for easy replacement, being secured to the barrel by means of a special locking nut. A split moulded handle is used, with all terminals easily accessible.

Comprehensive Vehicle Maintenance

A large and varied fleet of vehicles requires much in the way of servicing and repair equipment. A recent and notable installation is described.

EMERGENCY repairs can be carried out on fully-laden vehicles of up to 30 tons in the five bay "inspection pit" which is a unique feature of the new Maintenance Depot on the Reed Paper Group's site at Aylesford, near Maidstone, Kent. This service-dock is the only one in the United Kingdom built to support such a heavy load, and has been designed with an eye to future legislation which may raise the maximum laden weights of vehicles allowed on British roads.

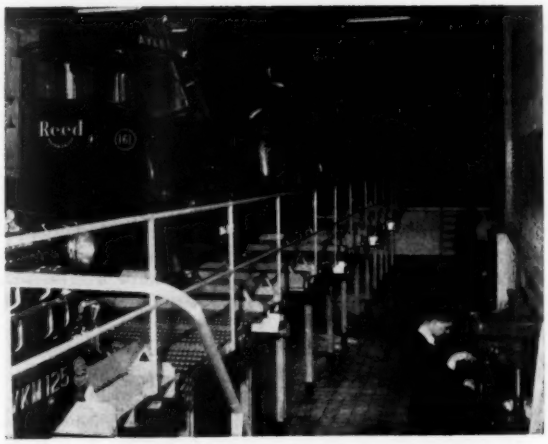
The headquarters depot, built and operated by Reed Transport Limited, provides 24-hr servicing and preventive maintenance for 200 commercial vehicles and 80 trailers, 100 cars, and 50 items of plant and specialised vehicles such as mobile cranes, dumpers and other civil engineering equipment, ambulances and fire appliances. Servicing for commercials and cars is carried out every 1500 miles. In addition, progressive maintenance routines are undertaken every 3000 and 6000 miles, with major overhauls at 30,000 and 60,000 miles. Items of plant are maintained on a time basis usually at intervals of a month.

The spacious building which was designed by Reed Paper Group architects, covers a floor area of 27,000 sq ft giving sufficient space for 12 eight-wheelers, a dozen cars and several pieces of plant equipment at one time. Headroom of 15 ft 6 in. throughout the servicing and repair bays gives ample clearance for the heavy pan-technicons and lorries in the Group fleet. There is a central 60 ft span area for "five-minute jobs" and for manoeuvring. On three sides of this are the service-dock, repair bays for commercials, cars and components, and a range of specialist workshops.

The five-bay service dock is a modern and well equipped "inspection pit" 2700 sq ft in area and 5 ft deep. In each bay vehicles can be jacked-up while on the 30 ft long reinforced tracks. The sides of the pit are white tiled and strip-lighting is provided down the length of the bays.

Workshop facilities for the service dock are provided both at and below floor level. Engine oil dispensers are mounted at ground level, and units for dispensing oils and lubricants are in the pit.

Full use is made of air powered equipment, supplied from two 68 cu ft per min compressors—providing outputs of 100 psi and 150 psi—installed in a separate compressor room. The larger output is used for tyre inflation and to pump all lubricants for the service-dock and outside fuel servicing island from the bulk containers in the oil store to the appropriate dispensers. In all repair and maintenance areas there are 100 psi plug-in points for pneumatic tools, and additional 150 psi connexions in the service-dock.



General view of the five-bay service-dock, the largest in the United Kingdom. The all-steel runways and stanchions can carry fully loaded vehicles of up to 30 tons, thus enabling emergency repairs to be undertaken without first off-loading.

Because of the diversity of makes and types of commercials and cars operated by the Group, the two-storey parts store carries stock of 40,000 items worth over £10,000, ranging from nuts and bolts costing as little as sixpence a dozen to heavy commercial diesel replacement engines valued at £900 each. An example of the wide range of parts available is that some 60 different fan belts are stocked.

The main parts store is supplemented by a night store, containing parts, such as oil filters for routine servicing, lamp bulbs or even radiators which may be required at short notice by the night shift.

The commercial vehicle repair bay, on the opposite side of the building to the service-dock, is equipped with gantry cranes to remove bodies for chassis overhauls, and a hydraulic floor-lift crane for handling heavy components. Other equipment includes a six-ton capacity mobile hydraulic trolley-press with a wide variety of applications —straightening body frames and body parts, withdrawing bearings and pins, and fitting new parts under pressure.

Engines, axles, and gearboxes can be completely rebuilt and reconditioned in the component part repair bay, situated between the commercial repair bay and the stores.

An illuminated cleansing tank is provided to serve the repair bays. Oily or dirty parts are put in the tank and cleaned by a high-pressure jet of detergent-solution and air.

The specialist workshops range along the back of the central area, stretching from the stores round to the service-dock. The car repair bay is in front of these workshops and has the most modern of present engine tuning and ignition testing equipment, and apparatus for checking headlamp beam setting.

The tyre bay is concerned with all sizes of tyres, from the small 10-3s used on gang mowers to 14.00-20s for cranes, and 19.00-20s for diesel lorries. Records are kept of all tyres, and after approximately 35,000 miles covers may be regrooved to gain a further considerable mileage before possible retreading. There is an immersion tank primarily for testing tubeless covers. A safety cage provides protection when it is required to inflate tyres to pressures as high as 100 psi.

In view of the two year guarantee given by all leading manufacturers, it has been found, in the main, more economical to replace doubtful batteries rather than

replate. Accordingly, the primary function of the battery room is to hold a ready-for-use stock of six and 12-volt batteries for immediate service. In this room all batteries are fully serviced, cleaned and cell densities checked before re-issue.

A portable fast-charging unit is available for starting light and heavy commercials. Operating from the mains current, it not only gives a boost to low charged batteries, but enables a full charge to be passed to the starter. This gives maximum efficiency within a few minutes and so frequently avoids the necessity of replacing flat batteries —a procedure that on some commercials entails removing four 6-volt batteries situated in positions that are not always readily accessible.

Equipment in the electrical room is for testing, servicing and reconditioning electrical components such as starter motors, generators, switch boxes, interrupter units, trafficators, screen wipers and oil gauges.

An injector testing room has been provided. At present it is used only for cleaning and testing injectors, but with the increasing number of diesel powered vehicles being brought into use, it may ultimately be considered necessary to add equipment for calibrating fuel pumps and servicing injectors.

The welding shop is equipped to tackle most repair and body work and both oxy-acetylene and electric arc welding can be performed. In addition, the services of the welder are available for the maintenance of fixed plant throughout the Aylesford site. It is envisaged that subsequently the scope of the welding shop will be extended to include trailer and chassis modification. The depot has been designed so that there can be expansion to provide a coachbuilding and painting shop adjoining the existing welding department, which will naturally play a prominent part in work of this nature.

The machine shop has a 60-ton hydraulic press for the sleeving of cylinder blocks and the removal and fitting under pressure of such items as heavy duty king pins and bearings. The brake relining machine is for shoes from 7 in. to 24 in. dia., and up to 8 in. width. It is capable of removing old rivets, drilling new linings, and securing new rivets. The surface of the relined shoe can then be ground to remove all high spots in order to give immediate braking efficiency. There is an extraction unit to remove the dust from the grinding process.

It is estimated that about 80% of valves removed from engines during the first top overhaul can be reclaimed on the valve refacing machine, which takes valve stems up to $\frac{11}{16}$ in. dia with a maximum head diameter of 4 in. This machine is portable and can be taken to the job for recutting valve seats on cylinder blocks. Other equipment includes a lathe, bench drill and power hacksaw.

Among the plant equipment maintained at the depot is a large number of lawn mowers, ranging from small hand models to gang mowers. The gang mowers are dismantled and reassembled on a special bench, and the blades are sharpened on a cylinder grinder.

There is provision for washing cars and commercials. Cars are cleaned, shampooed and dried off by hot air if necessary in a drive-through building erected against the main depot structure. The wash-down for steam-cleaning of commercial chassis adjoins the car wash.

Considerable thought has been devoted to the safety of personnel and all electric hand tools operate on a 50-volt system. The danger from trailing inspection lamp leads has been overcome by the installation of a system of overhead 12-volt wiring to which can be clipped inspection lamps wired on long "reach-up" poles.

Heat within the building is thermostatically maintained and there is an air-extraction unit to remove exhaust fumes. Steam for the heating system is supplied from the site's boiler house, which also serves the paper mills and converting factories. Messing, recreational and cloakroom facilities are all provided.

Electrodes for Vertical and Overhead Welding

An all-position electrode for mild steel welding which possesses exceptional qualities for use in the vertical and overhead positions while retaining all the essential features for downhand welding, has recently been introduced by Metropolitan-Vickers Electrical Company Limited, Trafford Park, Manchester 17. The versatile behaviour of the Vertivick electrode as it is called is due to the slag being sufficiently fluid when welding vertically to clear quickly from the molten pool, thus avoiding interruptions in the arc, and in the case of downhand welding, to absence of any tendency to flood the arc, even on medium rust or scaled plate. Desirable features claimed for the electrode are the ease with which the slag can be cleaned from the root run of vee-butt welds and the smooth and regular weld appearance with a close rippled finish noticeably free from spatter and undercut even in the vertical position. The electrodes available in seven sizes, $\frac{1}{16}$ $\frac{1}{4}$ in. and 4–12 gauge, are suitable for use with a.c. or d.c. (either polarity). With a.c. the electrode operates satisfactorily with open circuit voltage as low as 45. The B.S. 1719 Classification number for the electrode is E317.

BRITISH BUILT, AMERICAN DESIGNED NUT TAPPING MACHINE.—The first of a considerable range of National Machinery Company (Ohio, U.S.A.), products which are to be manufactured under licence in this country by W. H. A. Robertson and Company, Bedford, with sales and servicing by Buck and Hickman Limited, 2-6 Whitechapel Road, London E1. The high speed precision nut tapping machines are to be built in four sizes, $\frac{1}{4}$ in., $\frac{3}{4}$ in., $\frac{1}{2}$ in. and $\frac{3}{4}$ in. to thread hexagon nuts at respective tapping speeds of 96, 64, 48, and 27 Whit. nuts per min. An improved hook tap together with numerous advancements in machine design assures accuracy at high production. The machine is fully automatic and non-reversing. Separate lubrication and cooling systems, lead control and automatic safety shut-off devices contribute to trouble free operation. Other machines shortly going into production will be the National forging cold heading, Reducerolls and Maxipres machines

Salt Bath Materials and Methods

A review of current practice and notes on some recent developments

ALMOST all the salts employed in salt baths are hygroscopic in some degree, and they have the drawback that they adhere to the metal when it is taken out of them. They also result in a corrosive attack on the pots, the thermocouple tubes, the partly immersed work, etc. This corrosive effect is greater in proportion as the temperature of use is higher.

Again, the fact that the metal is coated with an unbroken film of salt on its removal means that there is a good deal of salt loss, but this disadvantage is offset to some extent by the fact that there is no difficulty in cleaning the work, while in some instances the salt film may be a boon because it prevents oxidation of the metal when taken out of the bath, and so encourages the obtaining of a fine finish on the surface. The thickness of the salt film and consequently the degree of loss are mainly governed by the fluidity of the bath.

The advantages of salt baths are that they soften the original heat shock by means of the insulating effect of the continuous salt film. They give a uniform and rapid heat transfer; and lastly they protect the work from scaling. Such an attractive combination of properties enables greater rates of output to be achieved in heat-treatment, and at the same time reduces expense.

There are three main types of salt baths: the low temperature salts, the medium temperature salts and the high temperature salts. Of these, the first are mostly used for tempering carbon or low alloy steels and operate at temperatures in the region of 540° to 600° C. The salts in the second group are employed for hardening, normalizing or annealing the same types of steel, and for the quenching of high speed steels. Salts in the third group are used for the hardening of high alloy and high speed steels. The medium temperature salts operate within the temperature range 540° to 900° C. The high temperature salts operate between 980° and 1310° C.

There has been a good deal of controversy regarding the type of pot that should be used at temperatures up to 700° C, but as regards those employed within the range 760° to 980° C, the heat and oxidation resistance of the cast high alloy pots render them unquestionably much superior to steel pots, whether pressed, cast or welded. In modern times the service life of metal salt pots at the higher temperatures has been the subject of considerable research, and the tendency is now towards using refractory-lined, electrically-heated units. These, however, have the drawback that they are expensive to buy and require a heavy supply of electricity at the high price now obtaining. Nevertheless, they are almost a 'must' for temperatures above 980° C, and should be lined with ceramic material for the best results.

The ability of the high alloy pots to withstand the attack of flue gas on their outer surfaces enables them to last sufficiently long a period for them to be eventually corroded by the salts they contained. One point that has emerged is that salt baths intended to protect certain metals from oxidation during heat treatment will themselves attack a high alloy pot. The explanation is that such corrosion is extremely slow, and involves solution of the metal combined with penetration into the grain boundaries, causing what is termed intergranular corrosion. This intergranular corrosion is much more dangerous than actual solution and leads in time to failure of the pot by reason of porosity, causing a percolation of the salt to the exterior of the pot.

As regards the alloys used for making these high alloy pots, there have been differing opinions, while the wide range of salts commercially produced and all possessing different powers of corrosive attack, have complicated the problem still further. Even more complexity has been added by the use of many and varied rectifying agents, introduced into the salt baths to prevent decarburization of the metal, but potentially dangerous to the pot itself by virtue of their corrosive effect. Research has been carried out which suggests that high alloy pots can be greatly improved, and some notes on this research will follow later.

The low temperature salts are usually nitrates and nitrites of the alkali metals. Typical examples are sodium nitrate and nitrite and potassium nitrate. These salts should never be heated above 590° C because otherwise they will react chemically with the work and the pot, attacking both. Care must be taken not locally to overheat any area of the pot, which should be brought evenly and slowly to the melting temperature of the salts.

Some low temperature salts are confined to a narrower temperature range than others, but cost less if the full range from melting point to maximum temperature is not required.

The medium temperature salts are usually chlorides and carbonates. Examples are potassium chloride and sodium carbonate in equal amounts. Such a mixture is primarily used for treating non-ferrous metals. It decarburizes the surface of steels, for which calcium chloride and sodium chloride (56:44) are better. Carbonates decarburize steel. Baths of chlorides only are the best, and the alkali chlorides are dealt with more easily. These medium temperature salts must not be heated to above 900° C because they tend to acquire atmospheric oxygen, lose their passivity, and form compounds that decarburize the surface of the steel. To prevent this rectifiers are used, such as fused borax,

boracic acid or boric oxide. These convert the oxidation products causing decarburization into fairly harmless sediment, which can be removed. Rectifiers are unsuitable for baths consisting of chlorides and carbonates mixed.

The high temperature salts are usually mixtures of barium chloride, borax, sodium fluoride and silicates. These salts soften *before* they liquefy, and their full melting range is from 870° to 1040° C. Some high temperature salts corrode the work slightly when new, but quickly become passive. Rectifiers such as ferro-silicon are sometimes used with these baths to prevent decarburization or scale. Such baths can be employed for preheating steel.

The primary requirements of a salt bath are that it should have as little corrosive attack as possible; be stable in composition; form no sediment or sludge; give off no poisonous, unpleasant or corrosive vapours; not be difficult to remove from the surface of the work; have little or no attack on the pot; melt readily and retain fluidity at the right temperatures; absorb little moisture from the surrounding air; be inexpensive and economical in use.

Cyanide salts must never be brought into contact with nitrates, as their intermixture at elevated temperatures may cause a severe explosion. The salts must be pure when bought and kept pure. No foreign bodies should be allowed to contaminate them or the bath. Accidental or careless mixing of groups of salts must be prevented.

Reverting to the pot materials, it has been shown that resistance of the alloy pot to corrosion is enhanced if a 15% chromium, 35% nickel alloy, or a 12% chromium, 60% nickel alloy, has its carbon content decreased from 0·5% to 0·442%. A 17% chromium alloy containing virtually no nickel will do as well as, or better than, some of the higher alloys in all the chloride type baths not containing notable quantities of carbonate.

If the lower carbon or straight chromium alloys are to be used, and strength is important, design may have to be modified. The low carbon alloys present casting difficulties and this again may call for change of design.

An important point is the preventing of heavy sediment or sludge at the bottom of the pot. At constant temperature such an accumulation has been found to increase the rate of intergranular corrosion to approximately 25% for many alloys, and to almost double for some. Moreover, the sludge, if present in quantity, gives rise to local hot spots and therefore higher corrosion. Properly looked after, a ceramic-lined pot should last from two to five years.

There is no need to provide nitrate salt baths with a hood at temperatures up to 540° C, but as all other baths operated at temperatures above this give off some degree of fume, it is advisable to introduce a system of ducting away these fumes, or a hood, or even both. Baskets, racks and fixtures in which the work may be held should be of steel for low temperature salts and of heat-resisting alloys for the other types. Constructions fabricated by welding if made of rolled forms have a longer service life than cast parts. It is advisable that all such equipment, and in addition any tongs employed for withdrawing work from the pot, should be solid, as otherwise oil or water from the quench may be introduced into the salt mixture, so leading to sputtering or minor explosions. Care should be taken to ensure that all equipment and also the work are completely dry before being immersed in the bath, and for the same reason.

The full efficiency of a salt bath is obtained only if automatic control of temperature is provided. Bimetallic thermocouples will be found adequate for low and medium temperatures, but for the higher temperatures within the range 1100° C and above, a radiation pyrometer should be substituted, and should have a closed-end target tube of ceramic or heat-resistant metal. This tube is placed in the bath and the pyrometer lens focused on its bottom.

The preliminary heating designed to liquefy the salts should not be too rapid, or the pot will be overheated, while the salts will not melt any the sooner, as they are incapable of absorbing heat at a greater rate than their composition allows. Overheating of the pot shortens its service life, while the layer of salts directly in contact with locally overheated spots causes corrosion of the pot and also a harmful lack of uniformity in the bath, as a result of basic composition changes caused by too high a heating rate.

Replenishment of the salt mixture periodically is essential, and the new material is best introduced before the pot is reheated, to avoid sputtering and possible slight explosions. This is impracticable when baths are operated continuously. If the work is so complicated in form that it traps a good deal of salt when it is removed from the pot, it may be necessary to add new salt more often than the period represented by the normal operating time of the bath, i.e. between heating up and growing cold. New salts should never be placed on top of the cold original salt, and care must be taken to ensure that the added material is perfectly dry.

Salt baths can be heated by oil, gas or electricity. Oil is mostly employed for large pots, as the long flame produced would overheat smaller pots. Gas-fired salt baths are effective if satisfactorily designed. Electric salt baths provide heat from metallic alloy resistors, and these will do good work at low and medium temperatures as long as the salts do not make contact with the resistors. The high temperature baths call for an immersed electrode type of furnace as earlier mentioned.

In addition to the operation mentioned, salt baths are being used today for liquid carburizing, cyanide hardening, neutral hardening, austempering, martempering, cyclic annealing and the heat treatment of high speed steel tools. They are also used for annealing, the brazing of steel and copper assemblies, the brazing of aluminium and its alloys, the heat treatment of aluminium and beryllium copper alloys, and the cleaning and descaling of metals. Among miscellaneous applications are the colouring of steel parts, the removing of enamel, heating for forming and forging, and the cleaning of metal moulds, in which a nitrate bath operating within the temperature range 320–430° C removes residual rubber, carbon black and lubricants from rubber moulds, both of cast iron and aluminium. The moulds to be processed are simply immersed in the bath from 10 to 30 minutes and then quenched in water.

Scales for Disc Calculators and Calculators for Practical Formulae

Further practical rules are given for the design of special scales, together with explanatory worked examples.

By R. K. ALLAN, A.M.I.Mech.E., M.I.P.E.

Disc calculators

To keep in line with slide rule nomenclature the largest disc is called the stock, and the others the slides.

The principles already determined for slide rules also apply to disc calculators, for the latter differ only in that the scales lie along the arcs of circles instead of straight lines, while the slides rotate instead of sliding, and all discs are held together not too freely by a central pin. Also, instead of marking off graduations as proportional lengths of a circumference, they are marked off as a proportional number of degrees, making use of a protractor. Therefore, in equations (1) to (17), l and N will be in degrees instead of millimetres; these equations are replaced by

$$l^\circ = Na \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1a)$$

$$l^\circ = N(l/r) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2a)$$

$$l^\circ = N \log c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9a)$$

and so on. For example, if $N = 2$ and $a = 90$, then $l = 2 \times 90 = 180°$.

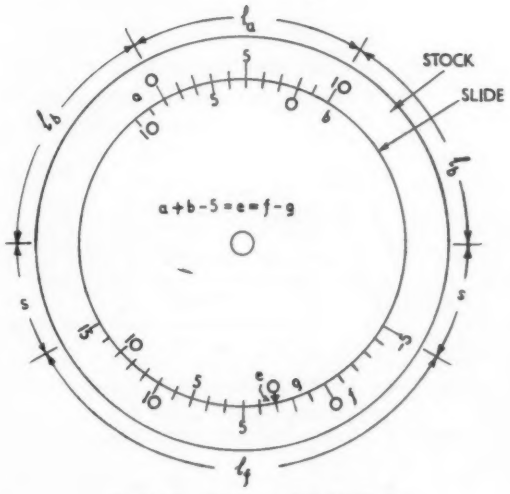


Fig. 24. Disc calculator equivalent to Fig. 22.

The diameter of these calculators should, naturally, be as large as possible to obtain well-spaced graduations, and particularly because with a number of slides each inner one will be smaller in diameter than its neighbour nearer the stock. It is simply a matter of making the smallest disc large enough.

The master disc can have its scale diameter the same or larger than that of the scales on the stock, but preferably larger. Obviously, when graduations are being transferred by means of a straight edge positioned radially, the centres of both discs must be coincident.

Fig. 24 is a disc calculator equivalent to the slide rule of Fig. 22 for the formula

$$a+b-5 = e = f-g$$

By Rule 5:

a (max) $= 10$
a (min) $= 0$
b (max) $= 10$
b (min) $= 0$
e (max) $= 10+10-5 = 15$
e (min) $= 0+0-5 = -5$
f (max) $= 15$
f (min) $= -5$
g (max) $= 10$
g (min) $= 0$

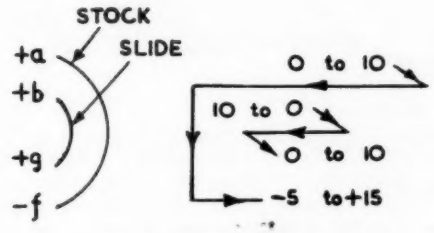


Fig. 25. Sketch diagram for Fig. 24.

By Rule 6:

First of all, overlapping of the scales should be avoided, and from Fig. 24 it is seen that this can be taken care of by

$$N(l_a+2l_b+l_f+2s) = 360° \quad . \quad . \quad . \quad . \quad (23)$$

where l_a, l_b and l_f are the total number of units in each scale, $2s$ representing the two blank spaces between the scales. From this we have

$$N(10+20+15+2s) = N(45+2s) = 360°.$$

Make $2s = 15$ so as to obtain a convenient value of N, then

$$N(45+15) = 60N = 360° \text{ and } N = 360/60 = 6°.$$

By Rule 7:

$$0 = \underbrace{+a-f-5}_{\text{stock}} \quad \underbrace{+b+g}_{\text{slide}}.$$ The constant can be ignored as it is taken care of by Rule 8.

By Rule 8:

Fig. 25 is the sketch for this, in which the zig-zag lines with arrows show the direction in which the values follow each other round the stock and disc.

By Rule 9:

The master scale range of s is from -5 to $+15$ and $l = 6s$ degrees. After graduating the other scales from this, write in the major factor values at their corresponding graduations.

Fig. 26 is the equivalent of Fig. 24, but with the a and b scales on a smaller diameter than the f and g scales there can be no overlapping, and the scale factor is thus increased from $N = 6°$ to $N = 15°$. Scale a is exposed by the arcuate opening cut out of the slide.

Fig. 27 is a disc calculator equivalent to Fig. 23, and the skeleton diagram is shown in Fig. 28 with the slides all set at the zero values. Note that in this case there is a projecting arm from the inner disc reaching to the scale on the stock, and that this carries the index mark. This manner of carrying over the index (or a scale when there is an even number of variables) is essential when there are more slides than one, otherwise the variables could not all be linked together simultaneously.

Calculators for practical formulae

In this section the sole object is to illustrate a few of the ways in which the principles already outlined may be applied to single and combined instruments for the solution of engineering and other formulae. These will be given in the manner usual in text books, so that the previous convention of using lower case letters for variables and capitals for constants will not apply. There will be no explanatory matter about the formulae themselves.

Three variables

Let $p^c = v$, then

By Rule 4:

$c \log p = \log v$, and

$\log c + \log \log p = \log \log v$

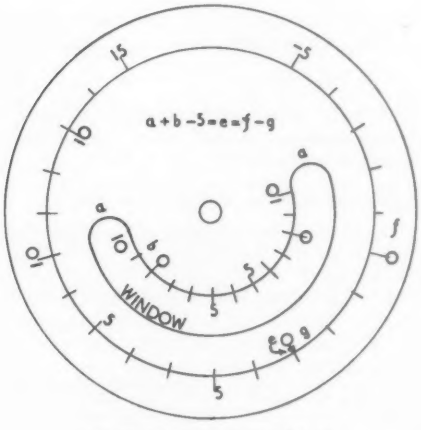


Fig. 26. Alternative design to Fig. 24.

By Rule 5:

p(max) = 10	log	10	= 1
p(min) = 1·259	log	1·259	= 0·1
	loglog	10	= 0
	loglog	1·259	= —1
c(max) = 4	log	4	= 0·6021
c(min) = 1	log	1	= 0
v(max) = 10^4 = 10,000	log	10,000	= 4
v(min) = 1·259	log	1·259	= 0·1
	loglog	10,000	= 0·6021
	loglog	1·259	= —1

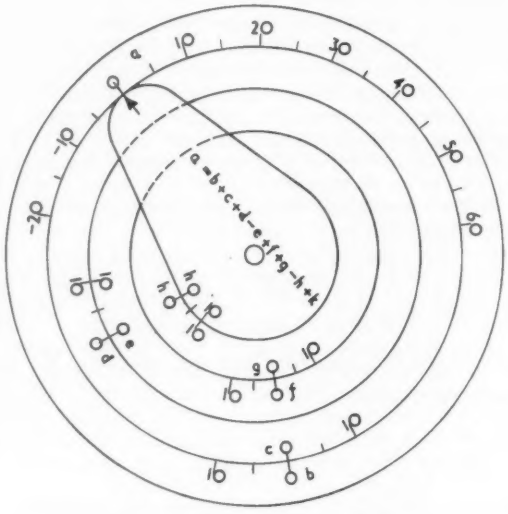


Fig. 27. Disc calculator equivalent to Fig. 23.

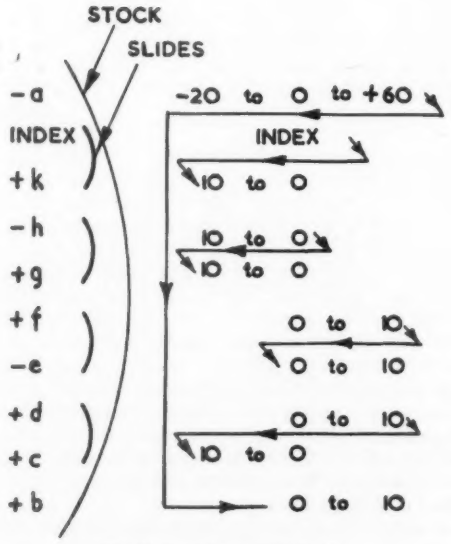


Fig. 28. Sketch diagram for Fig. 27.

By Rule 6:

v has the longest scale, and

$l_{max}-l_{min} = 160 = N[0{\cdot}6021-(-1)] = 1{\cdot}6021N$

$\therefore N = 160/1{\cdot}6021 = 100$ mm approx.

By Rule 7:

$$0 = \frac{-\text{loglog } v+\text{loglog } p}{\text{stock}} \quad \frac{+\log c \text{ and index}}{\text{slide}}$$

By Rule 8:

$-\text{loglog } v$	-1 to $0{\cdot}6021$	(v) $1{\cdot}259$ to $10{,}000$
index	index	index
$+\log c$	$0{\cdot}6021$ to 0	4 to 1 (c)
$+\text{loglog } p$	-1 to 0	(p) $1{\cdot}259$ to 10

The calculator scheme is on the left, the logarithmic range scheme in the middle and the numerical scheme on the right.

By Rule 9:

All the factors have been reduced to log values from which it is seen that the range of s is from -1 to $0{\cdot}6021$. Graduate the master scale from $l = 100\,s$ mm. From this scale graduate the others and write in the major factor values at the appropriate graduations.

Fig. 29 shows this calculator in which the scale of p, and that of v from $1{\cdot}259$ to 10, are the same as in Fig. 10. The scale of c is part of Fig. 9.

The band tension on a friction brake is given by

$T_1/T_2 = t = e^{0{\cdot}017453n\mu}$ where

T_1 = tension in tight side of the band

T_2 = tension in slack side of the band

t = ratio T_1/T_2

e = $2{\cdot}7183$ = the base of Naperian logarithms

n = angle of band contact, in degrees

μ = friction coefficient

By Rule 4:

$$\log t = 0{\cdot}017453n\mu \log e$$
$$= 0{\cdot}017453 \times 0{\cdot}4343n\mu$$
$$= 0{\cdot}00758n\mu$$

$$\text{loglog } t = \log 0{\cdot}00758 + \log n + \log \mu$$

By Rule 5:

t(max) = $12{\cdot}99$ $\log 12{\cdot}99 = 1{\cdot}137$
$\text{loglog } 12{\cdot}99 = \log 1{\cdot}137 = 0{\cdot}0557$

t(min) = $1{\cdot}11$ $\log 1{\cdot}11 = {\cdot}0455$
$\text{loglog } 1{\cdot}11 = \log 0{\cdot}0455 = -1{\cdot}3420$

n(max) = 300 $\log 300 = 2{\cdot}4771$

n(min) = 60 $\log 60 = 1{\cdot}7782$

μ(max) = $0{\cdot}5$ $\log 0{\cdot}5 = \bar{1}{\cdot}6990 = -{\cdot}3010$

μ(min) = $0{\cdot}1$ $\log 0{\cdot}1 = \bar{1} = -1$

By Rule 6:

Scale of t is to be 140 mm long, and

$140 = N[0{\cdot}0557-(-1{\cdot}3420)] = 1{\cdot}3977N$

$N = 140/1{\cdot}3977 = 100$ mm approx.

By Rule 7:

$$0 = \frac{+\log \mu-\text{loglog } t}{\text{stock}} \quad \frac{+\log n \text{ and index}}{\text{slide}}$$

By Rule 8:

$-\text{loglog } t$	$-1{\cdot}3420$ to $0{\cdot}0557$	$(t)\,1{\cdot}11$ to $12{\cdot}99$
index	index	index
$+\log n$	$2{\cdot}4771$ to $1{\cdot}7782$	300 to 60 (n)
$+\log \mu$	-1 to $-0{\cdot}3010$	$(\mu)0{\cdot}1$ to $0{\cdot}5$

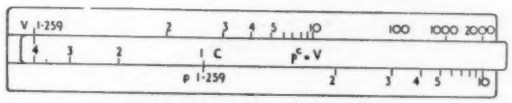


Fig. 29. Slide rule for variable exponent.

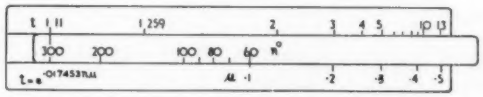


Fig. 30. Slide rule for two variable exponents and constant.

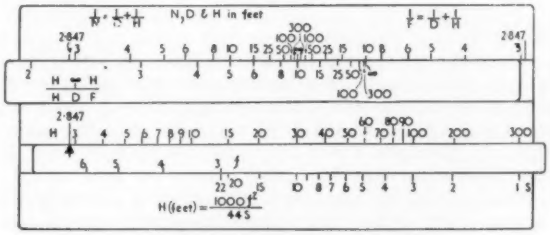


Fig. 31. Combined instrument for two formulae.

By Rule 9:

As all the factors have been reduced to log values, the range s is from $-1{\cdot}3420$ to $2{\cdot}4771$. Graduate a master scale by means of $l = 100\,s$ mm. Then mark off the calculator scales from the master one, and write in the major factor values in the appropriate places.

Fig. 30 shows this calculator.

Readers with an interest in photography will recognize

$H = 1000f^2/12 \times 12s$, $F = HD/H-D$, and
$N = HD/H+D$, where

H = hyperfocal distance, ft

f = focal length of lens, in.

s = lens aperture number

D = distance on which the lens is focussed, ft

F = farthest distance in focus, ft

N = nearest distance in focus, ft

By Rule 4:

Taking the first formula

$H = 1000f^2/(12 \times 12s) = 6{\cdot}96f^2/s$ and

$\log H = \log 6{\cdot}96 + 2 \log f - \log s$

By Rule 5:

f(max)	= 6	f^3(max) = 36	log 36	= 1·5564
f(min)	= 3	f^3(min) = 9	log 9	= 0·9542
s(max)	= 22		log 22	= 1·3424
s(min)	= 1		log 1	= 0
H(max)	= 6·96×36/1 = 250·6		log 250·6	= 2·3989
H(min)	= 6·96×9/22 = 2·847		log 2·847	= 0·4544

By Rule 6:

The log H scale is the longest, and to be 160 mm long.

$l_{max}—l_{min} = 160 = N(2·3989—0·4544) = 1·9445\ N$,

say $2\ N$

$\therefore N = 160/2 = 80$ mm.

By Rule 7:

$$0 = \frac{—\log H—\log s}{\text{stock}} \quad \frac{+\log f^3 \text{ and index}}{\text{slide}}$$

By Rule 8:

$\frac{—\log H}{\text{index}}$	0·4544 to 2·3989 (index)	(H) 2·847 to 250·6 (index)
$\frac{+\log f^3}{—\log s}$	1·5664 to ·9542 / 1·3424 to 0	6 to 3 (f) / 22 to 0 (s)

By Rule 9:

The range of log values s among the variables is from 0 to 2·3989. Graduate a master scale for this range or longer by means of $l = 80s$ mm and from it mark off the scales on stock and slide, and writing in the major factor values. Set $f = 3$ opposite $s = 22$ and mark in the index opposite $H = 2·847$.

This part of the combined instrument is shown in the bottom half of Fig. 31. Comparison with the middle and right-hand schemes above will show that the scales of f and s have been moved to the right as permitted under Rule 8.

Four variables

The other two related formulae in the last example under the heading "Three variables" will now be dealt with.

By Rule 4:

$F = HD/(H—D)$ can be expressed as
$1/F = 1/D—1/H$, and
$N = HD/(H+D)$ can be expressed as
$1/N = 1/D+1/H$.

Combining these by transposing we get

$1/F+1/H = 1/D=1/N—1/H$

Fig. 2 is the reciprocal scale and Fig. 16 the typical calculator to suit this equation of fractions.

By Rule 5:

F, N and D max $= \infty$
F, N and D min $= 2$
H ranges from —3 to +3.

By Rule 6:

H has the longest scale, and if its length is to be 160 mm,

$160 = N[\frac{1}{3}—(—\frac{1}{3})] = \frac{2}{3}N$
$\therefore N = 160\times 3/2 = 240$ mm.

By Rule 7:

As there are only two scales, this rule does not apply.

By Rule 8:

A decision has to be made whether N is to be read to the right or left of the origin of $H(a = 0$ or $H = \infty)$, as this determines in which direction the numbers increase on the slide. With N on the left, then since $1/N$ has a + sign and $1/H$ a — sign, by Rule 2 the numbers will increase in the same direction as those on the left of $H = \infty$.

By Rule 9:

The master scale of s is not really essential in this case, as the graduations can easily be marked in directly. It must cover the range *2* to ∞, and by equation (2) is graduated from

$$l = N/s = 240/s \text{ mm}$$

This part of the combined instrument is finished off as shown in the top part of Fig. 31.

When using the instrument, first find H from the bottom part. Then set D under ∞ and F will be found under the value of H to the right and N under H to the left. The small diagram at the left of the upper slide is the guide to the reading of this part of the instrument.

The wall thickness of heavy pipes is given by

$$t = Kd = \frac{d}{2}\left[\frac{(3f+2p)^{\frac{1}{3}}}{(3f—4p)}—1\right] \text{ in which}$$

for K_{max}, $f = 2p$, and for K_{min}, $f = 100p$.
t = thickness of pipe wall, in.
K = an auxiliary variable
d = bore of pipe, in.
f = maximum tensile stress in the material, psi
p = excess of internal over external pressure, psi.

By Rule 3:

Eliminating d by transposing, and introducing auxiliary variables g and h,

$(2K+1)^3 = (3f+2p)/(3f—4p) = g/h$.

By Rule 4:

In group 1, $3f+2p = g$.

By Rule 5:

f max	= 10,000	$3f$ max	= 30,000
f min	= 2,000	$3f$ min	= 6,000
p max	= 5,000	$2p$ max	= 10,000
p min	= 100	$2p$ min	= 200

g max $= 3\times 10{,}000+2\times 5{,}000 = 40{,}000$
g min $= 3\times 2{,}000+2\times 1{,}000 = 8{,}000$ (as f min = 2,000 = $2p$ $\therefore p = 1{,}000$)

By Rule 6:

g is the longest scale and is to be 120 mm long, and

$120 = N(40{,}000—8{,}000) = 32{,}000N$
$\therefore N = 120/32{,}000 = 0·0037$ mm, say 0·003 mm.

By Rule 7:

$$0 = \frac{—g+3f}{\text{stock}} \quad \frac{+2p \text{ and index}}{\text{slide}}$$

By Rule 8:

$-g$	8,000 to 40,000	(g) 8,000 to 40,000
index	index	index
$+2p$	10,000 to 200	5,000 to 100 (p)
$+3f$	6,000 to 30,000	(f) 2,000 to 10,000

By Rule 9:

In the master scale, s ranges from 200 to 40,000, and $l = 0{\cdot}003s$ mm. Graduate the other scales from the master and show the major values.

By Rule 4:

In group 2, $3f - 4p = h$.

By Rule 5:

f and p maximum and minimum are as for group 1

$4p$ max = 20,000
$4p$ min = 400
h max = $3\times10{,}000 - 4\times100 = 29{,}600$
h min = $3\times2{,}000 - 4\times1{,}000 = 2{,}000$

By Rule 6:

Use value of $N = 0{\cdot}003$ as for group 1.

By Rule 7:

0 =	$-h+3f$	$-4p$ and index
	stock	slide

By Rule 8:

$-h$	2,000 to 29,600	(h) 2,000 to29,600
index	index	index
$-4p$	400 to 4,000 to 20,000	(p) 100 to 1,000 to 5,000
$+3f$	6,000 to 30,000	(f) 2,000 to 10,000

By Rule 9:

Use master scale of group 1, as it covers this range.

By Rule 4:

In group 3, $(2K+1)^3 = g/h$, and
$2\log(2K+1) = \log g - \log h$.

By Rule 5:

K max $= 0{\cdot}5$ $(2K+1)^3$max $= 4$
$\log 4 = 0{\cdot}6020$

K min $= 0{\cdot}005$ $(2K+1)^3$min $= 1{\cdot}02$
$\log 1{\cdot}02 = 0{\cdot}0086$

g max $= 40{,}000$
$\log 40{,}000 = 4{\cdot}6021$ (for K max)

g min $= 8{,}000$
$\log 8{,}000 = 3{\cdot}9031$ (for K max)

h max $= 3\times10{,}000 - 4\times100 = 29{,}600$
$\log 29{,}600 = 4{\cdot}4713$ (for K min)

h min $= 3\times2{,}000 - 4\times1{,}000 = 2{,}000$
$\log 2{,}000 = 3{\cdot}3010$ (for K max)

By Rule 6:

h has the longest scale, with length of 120 mm max as for groups 1 and 2, and

$120 = N(4{\cdot}4713 - 3{\cdot}3010) = 1{\cdot}1703N$

$\therefore N = 120/1{\cdot}1703 = 102{\cdot}5$ mm, say 100 mm.

By Rule 7:

0 =	$-2\log(2K+1)+\log g$	$-\log h$ and index
	stock	slide

By Rule 8:

$-2\log(2K+1)$	0·0086 to 0·6020	
index	index	
		(K) 0·005 to 0·5
		index
$-\log h$	3·3010 to 4·4713	
$+\log g$	3·9031 to 4·4800 to 4·6021	
	(h) 2,000 to 29,600	
	(g) 8,000 to 30,200 to 40,000	

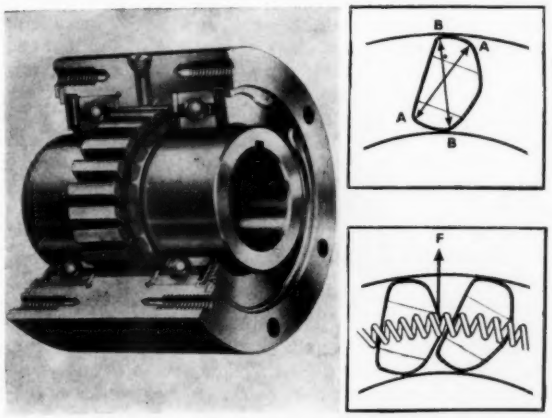
To be concluded

Spring Loaded Sprag Clutch Combats Backlash

Complete absence of backlash is a notable feature of the Renold sprag clutch, another addition to the Renold range of power transmission accessories now available in more than 70 standard sizes from 50 lb/in. to 136,500 lb/ft torque capacity and .250 in. to 12.00 in. bore size.

The Renold sprag clutch can be used as a free wheel, a one-way or "hold back" clutch, and as a means of indexing. The design allows for a full complement of sprags, thus giving high torque capacity combined with comparatively small size. Power is transmitted from one race to the other by the wedging action of the sprags between them. Each sprag (fig. 1) is so shaped that dimension AA is greater than BB. Rotation of one race in the 'driving' direction causes the sprags to tilt, thus transmitting the torque from one race to the other. An expanding coil spring (fig. 2) actuates the sprags, exerting on each one a tilting force which keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races.

Sprag clutches of this design have been marketed in the U.S.A. for the past 13 years by Formsprag Company, of Detroit, and have proved successful in a wide range of applications, including dual and multi-speed drives, conveyors and elevators, feed mechanisms and automatic gear boxes. Renold Chains Limited, Manchester, are now licensed to manufacture them in this country.



Left, Renold sprag clutch for ½ to 2½in. bores. Right, figs. 1 and 2 show the action of the sprags.

technique

devoted to the discussion of practical problems. Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance. Payment will be made for published contributions

Any Questions? We welcome inquiries concerning difficulties arising out of our readers' general work, for treatment in the **technique** section. The full name and address of the writer (not necessarily for publication) must accompany each communication

Small Vice for Light Grinding and Drilling

Small built-up vices of the type seen at Fig. 1 are generally associated with the tool room and there are several designs for which various claims are made regarding their suitability for particular work in that field. The design illustrated here is ideally suitable for light drilling and grinding for numerous articles which are too small to hold satisfactorily with the fingers despite the simplicity of the operation, and though the vice was originally made for use on the tool fitting bench, it will also find a ready place on light assembly work where the above mentioned processes are required for some minor operation and no appropriate fixture or jig is provided.

The design centres around the fact that only finger tightness is desired for this work, and this makes it possible to use a long clamping member A without fear that the pressure will cause the screw to bend; hence it becomes possible to move the loose jaw B back and forth a considerable distance and so increase the scope of this accessory.

Two substantial steel strips C form the body of this vice, and these are case hardened to preserve their appearance and to prevent damage through contact with other items either on the machine table or while in storage. Usually this class of vice is not held down on the machine table by means of clamps—during drilling the parts clamped in the jaws require very small holes and the radial pressure is not sufficient to cause the accessory to turn while cutting is in progress, and for grinding the magnetic chuck is the accepted means of securing it against a tendency to move. The provision of two long side slots seen at Fig. 1 is, therefore, only for those isolated examples that occasionally arise in the workshops where a finger clamp is essential because the work of drilling is perhaps performed easier when both hands are free to manipulate the setting or it is preferable not to disturb the set once the initial drilling has taken place.

The "fixed" jaw D has two screws the release of which will allow it to slide up and down and so provide a high or low backing for the other jaw to suit a particular component.

However, for long periods a change of setting is unnecessary as a slight variation in thickness of a detail is of no consequence, but the inclusion of two keys is a useful feature because they hold the outer strips parallel and always ensure that the clamping member B can slide to and fro without encountering a tight position. Small steel plate E and F underneath the side details overcomes the possibility of the strips moving a little while the jaw is adjusted.

Both the clamp and block holding the screw, B & G, can slide up and down as the block, while locating in slots machined in the side details, is free to move once the headed screws have been loosened; little pressure is needed to hold this block as the action of securing the component causes a thrust against the side slots.

Underneath the main clamping screw is another of similar length, and while both are used in conjunction, the former holds the pieces and the lower takes the thrust. The jaw D is used as an end support for this screw.

Fig. 2 indicates the general dimensions for this class of vice. Some variation is feasible, but the emphasis is toward a small accessory rather than a large vice, with drilling being limited to about $\frac{1}{8}$ in. dia drills and grinding to mere skims of about 0.0005 in. No suggestion is made that this vice is fit for vertical or horizontal milling operations.

All the parts in addition to the previously mentioned detail are case hardened with the exception of the screws, and these, if made from an alloy steel rather than mild steel, will not bend when pressure is applied. A coarse knurl to the heads of the latter pieces is sufficient, but if the vice is used where excessive coolant or oil is present, then an $\frac{1}{8}$ in. dia tommy hole is permissible as this gives just that extra tightness which the greasy hands cannot achieve.

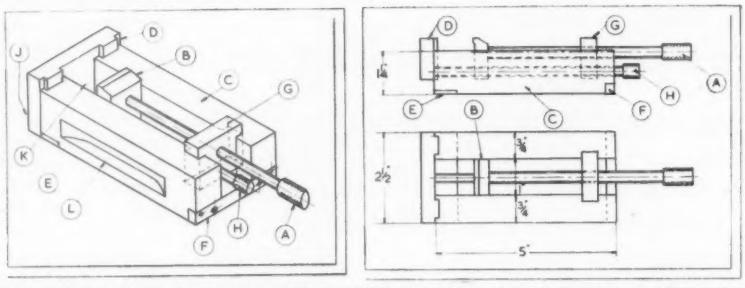


Fig. 1 (left) Design for small built up vice and Fig. 2 (right) the general dimensions. A, clamping screw; B, loose jaw clamping member; C, steel strips; D, fixed jaw. E, plate holding vice together; F, plate holding sides together; G, screw block; H, thrust screw; J, screws in elongated slots to allow vertical movement of jaw; K, small elongated slot in jaw to take end of screw "H"; L, clamping slots (optional)

Finally a small holding device of this type is often useful when marking out components so tiny that the orthodox toolmaker's clamp almost completely covers it; thus grinding the sides and ends square with each other is advisable during the initial stages of construction.—

John Waller.

Tumbler for Paint Conditioning

Cellulose enamel will thicken at the bottom of the container if allowed to stand, and at the works of E. Atkins Limited, Alperton, Wembley, Middlesex, the operators engaged in the paint spraying department used to spend 40 min per day stirring the

drums of cellulose until it was ready for use or (if necessary) thinning. The 17 lb cans of filler also needed to be stirred before they were fit for handling.

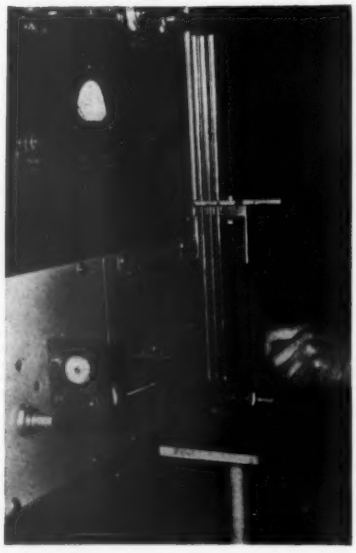
To keep the paint continuously in condition the company's chief engineer, Mr. R. Anderson, M.I.PlantE., designed and made a paint tumbling machine at a cost of only £300. It is powered by a ½ hp electric motor with push-button control. Four 5-gal drums of cellulose enamel and two 17 lb cans of filler are inserted in holders on each side of a rotating spindle, and as the machine turns, the contents of each drum are tumbled and kept ready for instant use. In storage the cellulose and filler are kept in a warm atmosphere to prevent the thickening which takes place at a low temperature.

Induction Heating in Blowpipe Manufacture

The use of induction heating methods for the brazing of components demands a high standard of coil design and efficiency. It is not always possible to adopt orthodox coil design for particular components on account of their shape, and this was true of the Saffire hand welding and cutting blowpipes made by British Oxygen Gases Limited (Equipment Division).

The brazing assembly consists of three stainless steel tubes connected to an angle nozzle head, together with hard brazing rings. Using the orthodox method of brazing, the assembly was fixed in position on a "rise and fall table" which was raised to allow the tubes to pass through a closed coil until the assembly reached the brazing position. After the components had been subjected to a rapid air quench, the table was lowered so that the assembly could be removed. During the period when the table was in operation, the induction heating machine lay idle. It was decided that production could be increased if a new type of coil was designed which would eliminate the need for the table to be used.

A new coil was constructed in three parts. Two water-cooled forks were made to fit the contour of the component, with a slight taper at the front of each member. These were attached to a fixture of insulating material and mounted on a fixed pedestal. A wedge piece with a taper corresponding to the taper on the forks was then attached to the work-holding fixtures. This was made to slide horizontally in runners on the fixture holding the coil, the wedge piece completing the circuit. A micro switch was attached to a runner on the coil-holding fixture to ensure that the current could not be switched on until the work was in position, thus preventing arcing. The three tubes, angle head and brazing rings are slid into the new split coil and the induction heating machine completes its brazing cycle immediately.



Special induction coil and fixture for blowpipe manufacture

This new coil and fixture has enabled the advantages of the induction method of brazing to be fully utilised. While the brazing operation is being carried out, an additional work-holding fixture can be loaded, thus ensuring maximum machine utilisation and increased productivity.

The "Executive" Shop Foreman

THE subject matter of the note by Donald Mack in the December issue is one of perpetual topicality. The fact that this is so is indicative that, as in so many other aspects of human relations within industry and in any other field of human activity for that matter, finality of procedure is never reached. Relationships between people can never be defined in a precise manner with a view to a particular code of conduct being laid down for all and sundry to follow in a given set of circumstances.

The psychological make-up of every individual is different and each foreman has to work out his own salvation in dealing with the type of problem outlined by Mr. Mack.

Whilst generally agreeing that the foreman should not necessarily lay down whatever he is doing in order to investigate immediately a complaint by one of his men, it appears that in the instance under review, the man was a shop steward and therefore an elected representative of the men on the shop floor. As such he was entitled to be heard by someone in authority, and the fact that he did not go to his section leader in the first place indicates that either he had no confidence in the latter's ability to resolve the points at issue, or that he knew there would be an automatic reference of the complaint to the foreman. It is not possible to get a clear idea of what went wrong since the nature of the complaint is not stated. If it resulted from some edict of the foreman being resented, then it was of little use complaining to the section leader; if the resentment arose from something the section leader had said or done then he should have known all about it if he was doing his job properly and if he felt he was in the right, *he* should have gone to the foreman for guidance and backing, if necessary. The fact that the whole business developed into a fracas—to use Mr. Mack's own word—is a pointer that somebody was wrong somewhere and the suggestion of the foreman to defer investigation of the complaint until next day did nothing to help matters even if it was only the shop steward who was wrong.

True, most foremen are painfully familiar with the type of man who likes to engage him in conversation on the slightest pretext. If this desire to converse arises from a vanity complex, then such vanity is not peculiar to men on the shop floor! But quite often the loquacious man can say something worth listening to, and if he is repeatedly referred to a lesser luminary, the foreman may lose something of value and he may even discourage permanently a good man and he has then made a potential enemy.

In these circumstances the foreman's job is no sinecure and it is in the handling of such situations that

his real ability and qualities of leadership become apparent. If he is to be "much in evidence on the shop floor, taking a keen interest in shop discipline and the methods employed by the several men in the execution of their various jobs" then the foreman can hardly refer every question, particularly those of a technical nature, to the chargehand for the final word. If he does this, he will soon earn the reputation among his men of not knowing his job, or even worse, of not being interested in what his men are doing.

Surely, the most satisfactory procedure when making the daily rounds of the shop floor—and the best foremen will regard this part of their duties as the most satisfying and useful of the day—is for the appropriate chargehand to accompany the foreman. Whatever questions arise can then be dealt with jointly and many of those trips made by men to the foreman's office, which are such a fruitful source of annoyance and so productive of ineffective time, cease to be a feature of the daily working. What is more important, the chargehand is being educated in the manner of dealing with men and the things which irritate them, and the foreman is demonstrating that he has confidence in the chargehand and his ability to deal with minor crises. Men are not so ready to dash with a complaint to the foreman's office if they know that they are only likely to get the same answer there as if they had approached the chargehand in the first place.

What Mr. Mack's highly interesting anecdote does do is to emphasize the necessity for proper training of supervisors of all grades immediately on appointment and before they assume the reins of office. Some excellent courses are now available for this purpose and a residential course of three–four weeks duration can earn handsome dividends by virtue of the way in which it can assist an industrial enterprise to be run smoothly by properly trained staff. It is suggested further that to get the maximum benefit from formal training, successful candidates for promotion should undergo a course at each step up the ladder. There is a vast difference between the job of the shop foreman and the works manager, for instance, in so far as the intangible aspects of the respective jobs are concerned, and a short course of training prior to taking up a new post cannot help being of assistance to the "new boy". Training is no substitute for experience hardly won, but it can smooth the path of entry of the new boss so that there is less likelihood of disturbing the men on the shop floor with the consequent loss of production which such disturbance entails, when the new broom starts to sweep clean.—**W.G.F.T.**

Conveyor Strap Belt Tensioning Device

A method of reducing the initial tension necessary in conveyor belts to provide the driving friction between belt and driving drum has been devised by Mr. R. G. Baker, Deputy Chairman of the North Eastern Divisional Coal Board. It embodies a light gravity take-up on the slack side of the belt, coupled with the use of a pressure or strap belt in the drive head. The strap belt provides additional friction at the point of contact between the main belt and the driving drum, and is adaptable to both single and double drum drives.

With conveyors of the endless belt type it is necessary to provide sufficient pressure between the belt and the driving drum to ensure that the belt is driven by the drum without slip. In the past this has usually been achieved by giving the belt an initial tension. However, since the sum of the initial tension and the tractive force in a belt should not exceed the maximum permitted working stress, it follows that, with the reduced initial tensioning associated with the pressure belt drive, a greater tractive force can be applied to a belt of given size, or a belt of lower strength may be used for a particular load.

With Mr. Baker's invention the initial tension which has to be applied need be sufficient only to prevent the belt sagging unduly between the return idler rollers of the conveyor. To realise this low initial tension in practice, and because of the slack which appears in the return belt as the load on the belt increases, it is necessary to use a light gravity take-up This may conveniently be incorporated in the loop take-up normally provided.

A short auxiliary belt is provided in contact with all or part of the outer surface of the conveyor belt as it passes around the driving drum or drums. The tension in the auxiliary belt is adjusted so that it holds the conveyor belt against the drum with sufficient friction for the drum to drive the conveyor belt without slip.

Two arrangements of drive heads for use in the system are shown in the accompanying illustrations. Fig. 1 shows its application to a standard single drum conveyor drive gear. It shows the driving drum 10 for a conveyor belt 11 which in the usual way passes over an idler 12, round the drum, and then over another idler 13. Also passing over the idlers 12 and 13, and the drum 10 is the auxiliary or strap belt 14 which is on the outside of the conveyor belt as it passes over the drum and

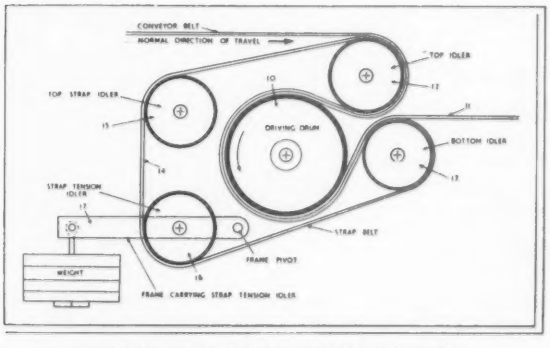


Fig. 1. Pressure belt applied to standard single drum drive

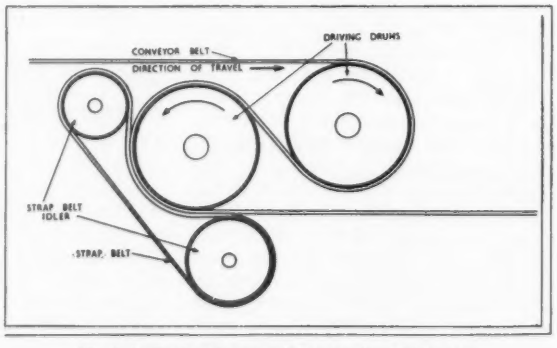


Fig. 2. Application of pressure belt to two-drum driving gear

on the inside as it passes over the idlers. The strap belt is taken over two further idlers 15 and 16. Idler 16 is carried by a frame 17 pivoted at one end and having at the other end a holder and weights. These weights are varied to adjust the tension in the strap belt, so that it holds the conveyor belt against the driving drum with sufficient pressure for the drum to impart drive to the belt.

Fig. 2 shows how the invention is adapted for use with a two-drum driving gear. In this case the strap belt is brought into contact with the conveyor belt for part of its travel over one of the driving drums. The means of tensioning the strap belt is not shown in this drawing.

The gravity take-up arrangements are not shown but are of any known type which will permit of sufficient travel of the tension idler drum.

Difficulties with a Blanking Punch

IN every cutting die (blanking, punching, trimming, notching, etc.) there are two cutting members: the die plate and the punch. By definition, the die plate determines the outside shape and dimensions of the work-piece and the punch the inside shape and dimensions. According to their functions, both members must be designed along certain basic principles, somewhat different for each member.

However, things are not always perfectly clear and well defined, and in fact I had an interesting yet simple case where the functions of the two cutting members were somewhat intermingled.

The blank in question is a part for a fluorescent socket, Fig. 1. (By the way, subsequent forming operations went all right.)

For its production I made a standard, progressive type blank and piercing die which worked satisfactorily in the tryout, but at the beginning of the regular manufacturing it gave serious trouble.

As it happened, at the narrow slot in the arm the roles of the two cutting members are inverted, i.e. a protuberance in the die plate acts as punch, and a slot in the punch body acts as the die plate. In the construction of the tool this circumstance was not taken into account and the slot in the punch body had been made simply parallel (instead of tapered, opening upwards). The consequences were that the corresponding protuberance in the strip-skeleton was not separated from the punch, but remained firmly embedded in the punch and broke away from the strip-skeleton. After a short while, the slot was full of slugs and the frail protuberance in the die plate broke away.

The remedy, after recognizing the cause, was easy. First, we made the slot body slightly tapered and

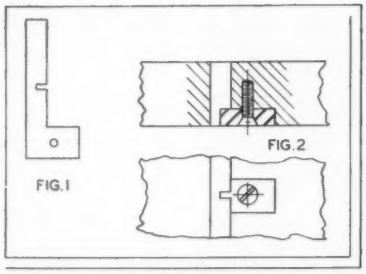


Fig. 1. Part of a fluorescent lamp socket, an example of a narrow slotted component. Failure to clear the protuberance left on the strip-skeleton led to breakage of the die plate

Fig. 2. A simple stripper-piece to ensure the punch is completely stripped

secondly we put a supplementary piece of stripper in a recess at the bottom side of the stripper plate (Fig. 2). The stripper-piece (made from hardened tool-steel) has a nose which is a loose fit to the slot. This stripper-piece ensures that the strip is stripped entirely from the punch.

Copying Punches on to Die Plates

IT often happens that small round piercing punches must be copied upon die plates while both members are already mounted in the die-set. A device which has been found to be a great time-saver consists of a mechanic's parallel clamp with one

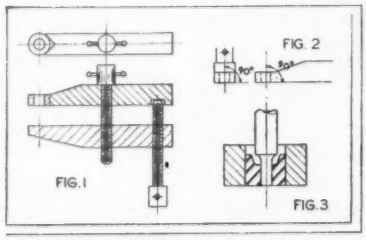


Fig. 1. Simgle adaption of a parallel clamp to form a bushing-carrier.

Fig. 2. The bushing-carrier made of steel tube must be welded perfectly square to the clamp surface.

Fig. 3. Hardened tool steel bushes are made to suit the punch point diameters and bushing-carrier.

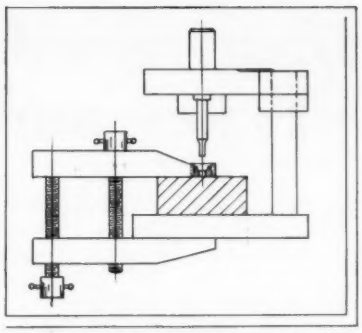


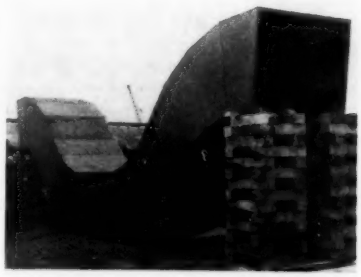
Fig. 4. The clamp closed over the die shoe. After removing the punch the bushing may be used as a convenient drilling bush

nose cut away and a bushing-carrier of steel tube welded thereon as shown in Fig. 1. The tubing must have its axis square to the clamp-surface. (Fig. 2.) With this is used a series of bushings prepared from tool-steel, hardened and ground, an exact fit in the carrier and having bores to fit the punch point diameters exactly (Fig. 3).

After mounting punch and die-plate in the die-set, a bushing is put on the punch-point and introduced into the bushing carrier. After closing the clamp tightly on the die shoe (Fig. 4) the punch is taken away and the bushing remains as a convenient drill bushing for drilling a hole in the proper place on the die-plate.

For heavy stock punching, the hole must be made larger (by the amount of the clearance), and the original bushing may be substituted by another having the required bore.

—F. Strasser.



TUBULAR AIR CROSSING.—This sectional tubular air crossing for underground ventilation systems, designed by Mr. A. Ashley, Group Chief Planner in the N.C.B. East Midlands Division's No. 6 Area, and Mr. L. C. Hogg, the Deputy Area Production Manager (Operations), replaces crossings of brick and steel construction and can be dismantled and used elsewhere. The sections are $\frac{1}{16}$ in. steel plate faced with flat bars $2 \times \frac{3}{4}$ in. drilled for $\frac{1}{2}$ in. bolts to secure the sections together. The bolts are inside the tube to give protection against corrosion. Foam rubber packing provides an air-tight seal. All sections are identical and interchangeable. The tube is 5 ft by 4 ft. End sealings are stoppings of brickwork or sandbags.

High Speed Steels —Types and Treatments

In an environment of new tool materials the high speed steels continue to evolve and to meet demands for ever-increasing performance. Their scope is readily appreciated from a simple grouping of composition and properties which serve also as indicators to spheres of application.

OVER the last fifty years there has been an astonishing development in the design and power of machine tools, and high speed steels have had to develop to keep pace with this. They have for certain operations been replaced by the cutting alloys, such as Stellite, tungsten carbide, Tantaloy, titanium carbide, the ceramics, etc., but they still have a wide sphere of operation and have been vastly improved since their early beginnings.

Irrespective of their source, the high speed steels are markedly similar in their physical composition. Virtually all of them have an extremely high percentage of alloying elements in their composition, together with enough carbon to give them great hardness. All are heat-treated at temperatures slightly below melting point to give them adequate hardness, and all can be hardened throughout their entire cross-section in the section in which they are likely to be used. In addition, they are all capable of attaining almost their maximum hardness by being cooled in still air.

Nevertheless, by themselves these properties would not suffice to give them the remarkable cutting properties they possess. The one predominant requisite is that they should be able to keep a high degree of hardness at elevated temperatures, and particularly such temperatures as involve a red heat. This they do, retaining a good hardness even when the friction of cutting has generated enough heat at the tool nose to make the tool glow red.

There is a great difference between the high speed steels made in Britain and those made in the United States. In this country the standard high speed steels (leaving out temporarily the high cobalt 'super' high speed steels) contain from 12 to 18% tungsten. The United States is short of tungsten and replaces it by molybdenum, of which approximately one half will give the same effect as one per cent of tungsten. During the Second World War, Britain had to adopt molybdenum high speed steels also,but certain difficulties are found with these steels, and to some extent they have again disappeared from the British steel, though some firms continue to market at least one molybdenum high speed steel.

We can thus say that there are, in all, six classes of high speed steels, namely the 14 to 18% tungsten high speed steels; the molybdenum high speed steels; the tungsten-molybdenum high speed steels; the tungsten-cobalt steels containing from 18 to 22% tungsten with from 5 to 12% cobalt; the molybdenum cobalt and the tungsten, molybdenum-cobalt steels. Since this article is primarily concerned with British high speed steels, we shall largely ignore the predominantly molybdenum-bearing steels of American manufacture.

Table I.—TUNGSTEN HIGH SPEED STEELS

Carbon	Tungsten	Chromium	Vanadium	
0.7	18.0	4.5	1.5	per cent.
0.8	18.0	4.0	2.0	" "
0.7	14.0	3.5	0.5	" "

The basic compositions of the standard tungsten high speed steels are given in Table I. All of these can be employed for cutting tools but for certain purposes their cutting power is not high enough, and therefore they tend to be replaced by more expensive steels.

To all intents and purposes there is little difference between the first two of these steels, which are designed for the ordinary class of work coming into a machine shop. They are reliable and of homogeneous structure, and suitable for turning, slotting, shaping, planing, drilling, reaming, rotary cutting, etc., where fairly heavy service is required. Some dies can be made from them, but for this the carbon content must be lowered to between 0.5 and 0.6% to ensure the necessary toughness.

The third steel of Table I is lower in alloy content and is designed for somewhat less difficult work than the other two. It is, however, largely disappearing from the scene, as the difference in price between it and the other steels does not compensate for its lower performance. The materials machined today are such that it is more economical to pay a higher price and obtain the much superior cutting power of the more highly alloyed steels.

The super-high-speed steels contain cobalt to the extent of between 5 and 12%, so that they are the most effective high speed steels known, and will cut the hardest and most difficult materials, such as cast iron, hard steels, castings with sandy skins, austenitic (11—15% manganese) manganese steels, stainless steels of austenitic type, white iron, etc. They are necessarily more expensive than the steels of Table I, and except in the form of butt-welded tools, of which enormous quantities are now made, they are economical only on the most difficult materials. Table II gives the compositions of these steels.

The distinctive property of these steels is their high cobalt content. The first and last steels of the Table are undoubtedly the most powerful cutting materials of steel type the metallurgist has so far produced. These two steels should be used only when the shop is equipped with machine tools capable of giving the high speeds and heavy cuts they render possible. 'Super' high speed steels can be used for all machining operations and all classes of tools, and can be forged, machined, annealed and hardened.

Table II.—SUPER HIGH SPEED STEELS

Carbon	Tungsten	Chromium	Vanadium	Molybdenum	Cobalt
0.8	22.0	5.0	1.5	0.5	12.0
0.8	18.0	5.0	1.5	0.5	6.0
0.75	14.0	4.0	2.0	0.5	5.0
0.7	18.0	4.0	1.0	0.5	5.0
0.8	20.0	4.0	2.0	0.5	8.0
0.8	20.0	4.0	1.25	0.5	12.0

They should not be confused with the cutting alloys or sintered carbides, such as Stellite and Tantaloy on the one hand, and tungsten or titanium carbide on the other.

The second and fifth steels of Table II are for heavy machining work where it is not economical to use the standard high speed steels but where the work is not quite so difficult as to require the more highly alloyed steel of the group. The remaining two steels of the Table can also do this class of work, but are not quite so effective as the higher cobalt steels, though superior to the standard high speed steels.

The modern British molybdenum high speed steel contains 0.85% carbon, 4.75% chromium, 5.0% molybdenum, 6.0% tungsten, and 2.0% vanadium. This steel is treated in much the same way as a standard 18% tungsten high speed steel, but it has a greater susceptibility to decarburization than the tungsten steels, and therefore must be forged, hardened and tempered at lower temperatures.

Before purchasing high speed steels, it is desirable that the user should appreciate precisely the type of tool he wishes to make; the type of steel that will be economical for his work; the best composition in that particular type or class of steels; the quantity he needs expressed either in bars or by weight; the shape in which he requires it, e.g. flat, round, square, etc.; the cross-sectional dimension; and whether the steel is to be delivered in the annealed or unannealed state. Usually bars are supplied annealed unless otherwise specified.

Where the steel is ordered by length, e.g. 10 ft bars, it must be remembered that if *exact* lengths are required, this should be indicated on the order, and the user must be prepared to pay an extra for cutting to precise lengths. Bars of high speed steel are usually from eight to ten feet long, and high cobalt steels weigh about 14% more than bars of carbon tool steel of the same length and cross-section. Ordinary high speed steels weigh about 10% more.

When a high speed steel is in the cast condition, as when first melted and allowed to solidify, it is composed of austenite grains surrounded by a skeleton-like eutectic. As the steel solidifies from the molten condition, the first solid to form contains low carbon and alloying elements. As solidification proceeds, the remaining liquid becomes richer in carbon and alloys until a point is reached at which it reacts at the eutectic temperature and precipitates austenite and carbide simultaneously.

To produce a satisfactory cutting material from this cast structure, forcing and rolling are essential, and these operations break up the carbides and elongate them, mainly in the direction of working. The correct hardness and toughness are given by later heat-treatments. When the steel is heated approximately to the melting point and then quenched, some of the carbide goes into solution. The average composition of a high speed steel should lie within or extremely near to the ferrite+carbide region. Higher carbon or lower tungsten produce greater quantities of iron carbide in the annealed structure. If the composition is modified in the opposite direction, i.e. higher tungsten and lower carbon, as in 0.5% carbon high speed steel, iron tungstides are found.

The alloying elements in the steels combine with carbon to form complicated carbides which do not easily precipitate out when the microstructure of the steel breaks up under the influence of high temperatures. Not only is there this slowness of precipitation, but in addition the clotting of these carbides, when actually precipitated, is retarded. Until precipitation and clotting take place, the steel does not become soft, and it is a peculiarity of high speed steel that both actions are required. It is also a feature of these steels that when the carbides have been precipitated out, they are extremely small in particle size. It is believed that this causes the retention of hardness by the steels when cutting at a red heat. Before the carbides can coagulate, so to speak, the atoms of all the alloying elements in the steel must be dispersed simultaneously throughout the mass.

The mass of tungsten and molybdenum in atomic form is believed to be greater than the mass of other atoms in the steel, so that their own atoms are incapable of diffusing throughout the body of the steel as rapidly as the smaller atoms of the chromium, vanadium and carbon alloying elements. This means they disperse at a slower rate, and clotting, followed by softening, is delayed. Hence arises the important property of red-hardness.

The grain size of high speed steel is important as affecting its performance. It depends mainly on the hardening and tempering or secondary hardening temperatures, the duration of the temperature, the composition of the steel and the way in which non-dissolved carbides are dispersed. Higher hardening temperatures and longer maintenance of temperature develop grains of larger size. Composition influences grain size because the lower the fusion point of the steel, as determined by its constituents, the larger the grains of the microstructure.

The size and shape of the cutting tool likewise affect the grain size, since the outer surfaces of a high speed steel bar usually carry finer particles of carbide and these are more evenly distributed. Consequently, the external surfaces of the bar possess superior cutting power, and while most cutting tools or high speed steel have the cutting edge in that portion corresponding to the outer surface of the bar, there are others in which the cutting edges inevitably correspond to an internal portion. Forging and mechanical working will improve such tools.

It has been suggested that an atmosphere-controlled furnace for heat-treatment improves grain size, but this has not yet been confirmed.

A good high speed steel should be red-hard, i.e. able to cut at a comparatively high temperature; resist wear at the cutting edge even under conditions of great frictional heat; and have a combination of strength, ductility and freedom from brittleness. All these properties must be co-existent. A good high speed steel should not distort or undergo a sharp change of volume when quenched in the usual media, but of course the risk of distortion becomes greater as the quenching temperature increases. After it has been heated to 480—540°C there is actually a contraction of the steel, but if it is heated above this temperature, an expansion occurs. There are certain movements of the steel of special character based on varying forms of heat-treatment, but these need not be specified here. The contraction of the steel up to 480°C is greater at the higher than at the lower end of the temperature range. Small tools, e.g. milling cutters, usually contract when quenched from a high temperature if oxidation takes place. If such oxidation is prevented, the steel expands.

The thermal conductivity of the steel, though having small effect on its cutting power, is important to service life. Maximum heat conductivity means a rapid dissipation of the frictional heat generated at the tool nose into the tool body. This keeps the cutting edges cooler and prevents them from breaking down too soon. Cobalt is

said to increase the thermal conductivity of the steels, but this is disputed, because high speed steels without cobalt are found to have equally good heat conductivity.

In choosing high speed steels, it must be remembered that no one type of steel covers all classes of tool and work. The standard 18% tungsten steels without cobalt are hard and reasonably ductile, keep a sharp cutting edge and are easily forged and heat-treated. They will take fine and finishing cuts on soft or hard materials. The cobalt-containing 'super' high speed steels keep their hardness and cutting power at higher temperatures and have even greater red-hardness, but the cutting power of tools made from them depends on the cobalt content. They are harder and less tough than the standard steels, and are therefore best used as butt-welded tools. They should in the solid form be kept for the hardest and most difficult materials where higher cutting speeds are desired than the other steels will give.

The molybdenum high speed steels are not so good for work on cast iron or material lacking homogeneity in structure and composition, but otherwise compare reasonably well with their counterparts. Their ready decarburization however, makes them more difficult to forge, work and heat-treat. It is said that they resist wear more effectively than the tungsten steels, but have somewhat lower red-hardness.

Factory Expansion for Radial Drill Manufacture

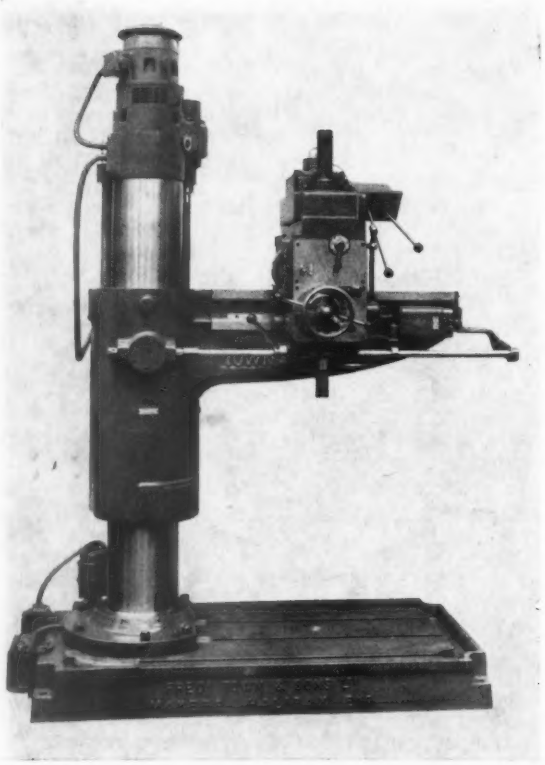
A review of the products and reconstructions made by Fredk. Town & Sons Limited at Mile Cross Engineering Works, Halifax.

THE radial drilling machine has long maintained popularity in the machine shop and reliable machines of sound design and construction continue to find a ready market both in this country and overseas. As makers of drilling machines for the past 55 years Fredk. Town and Sons Limited of Halifax, Yorks., have earned considerable reputation for their products, but the continued demands of the overseas markets have for a number of years severely taxed the capacity of their existing premises and plant so that the first task of Thos. W. Ward Limited, Sheffield, who acquired the entire share capital of the company in 1954 was the expansion and modernization of the works. However the links with the Town family have not been completely severed for today the reorganized works is under the general managership of the founder's grandson, Mr. Eric Town.

The main machine shop originally covered a floor space measuring 120 ft × 120 ft; with the new extensions a further 9600 sq ft have been added bringing the total area of the machine and erecting shop to 24,000 sq ft. New machines have been installed and include two Swift-Summerskill all-electric planing machines, a John Lund Precimax 10 in. × 100 in. cylinder grinding machine, a Pfauter spline hobbing machine and several other smaller machines. The foundry attached to the works continues to supply much of the smaller high grade cast ironwork up to 4 ton required for the machines, but the larger main castings are obtained outside.

Included in the re-equipment programme was the installation of a complete new heating system for the works and foundry using high pressure hot water generated in a Cochrane boiler and circulated through radiation panel heaters suspended overhead. Our illustration shows one of the two assembly bays which flank the main machine shop, each being equipped with 7½ ton overhead cranes; the new heating panels are plainly visible beneath the crane support work.

The complete range of Town machine tools embraces radial drilling machines from 3 ft up to 8 ft radius



The Town model A.E.6. high speed sensitive radial drilling and tapping machine is made in 3 ft, 3 ft 6 in. and 4 ft radius sizes.

with or without box beds, vertical drilling, boring and tapping machines of 3–3½ in. dia mild steel drilling capacity and bogie type girder radial drilling machines from 4 ft up to 8 ft radius. Representative of the latest high speed radial drilling and tapping machines the

Radial drilling machines in course of erection at Fredk. Town and Sons Limited

model A.E.6 shown in the illustration is manufactured in 3 ft, 3 ft 6 in. and 4 ft radius sizes. Nine spindle speeds from 88 to 1450 rpm are obtainable through hardened nickel-chrome steel gears mounted on short rigid 6-spline shafts, the speed changes effected by two levers. Three power feed rates operated by a lever on the front of the saddle give 80 to 200 rev. per in. or ·013 to ·005 in. per rev., any one of which can be used with any speed and sensitive hand feed by a lever at the right of the saddle. The spindle drive from a 2 hp constant speed reversing motor underslung at the rear of the saddle is operated by a single lever on the saddle which also controls arm elevation and lowering. The saddle of box form is easily handwheel traversed on ball bearings by steel rack and pinion and simultaneously locked with the arm by a single lever. The arm of ample proportions to withstand drilling stresses has roller bearings fitted to top and bottom of the barrel to ensure easy rotation round the column. Vertical power traverse is arranged by a 2 hp reversing motor at the top of the column controlled from the saddle. A safety slipping device fitted at the top of the elevating screw works in conjunction with the trip dogs situated at the extreme limits of the vertical arm traverse to prevent damage through over-traversing. These machines are designed to drill up to 1¼ in. from the solid in mild steel and 1½ in. in cast iron and tap ¾ in. Whit. in either material.

A Simplified Dynamometer for Power/Speed Tests

There are many instances where engines, motors, etc., have to be tested for power over a range of speeds, but where the highest degree of accuracy of power measurement is unnecessary. Again it is not always essential to measure the actual power absorbed, in many cases all that is required is some means of imposing a controllable load against the unit under test so as to run it at various speeds and throttle openings.

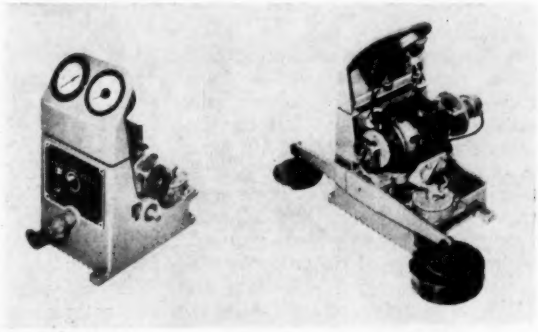
To meet these circumstances, Heenan & Froude Limited of Worcester are producing a new range, known as the I.E. brake or dynamometer. Basically it is a brake unit on general Froude principles, without torque-measuring equipment, and with cast-iron feet to bolt directly to the user's bedplate or foundations when only a simple power absorbing unit is required; or converting into a full-scale dynamometer by mounting it on a pivoted platform, and fitting a lever arm for measuring the torque-reaction forces.

The brake unit itself has novel features. Its power-absorbing elements (rotor and stator) are of the single-sided type, the resulting axial thrust is self-contained, and is amply within the capacity of the brake bearings. The load control gear is also a departure from the sluice-gate type previously used in the smaller sizes of Froude dynamometers; the load at any particular speed depends upon the quantity of water discharged into the brake casing by a pump impeller mounted on the brake shaft and the quantity is regulated by a hand valve fitted to the casing.

In previous designs of small dynamometers, the casings have been allowed the necessary rocking motion between no-load and full load by mounting them on trunnion bearings. These bearings have normally surrounded the shaft and have thus had to be of relatively large dimensions. In the I.E. design, they are replaced by much smaller pivot bearings placed vertically below the shaft axis. The resulting slight movement of the shaft itself necessitates a universally-jointed cardan shaft between engine and dynamometer; but such shafts are normally used in any case, and of the type easily capable of accommodating this movement. The brake unit on its pivoted platform is provided with a short lever arm, bearing upon a pressure capsule, coupled by small-bore piping to a pressure-gauge calibrated to give torque readings. In conjunction with the tachometer readings of speed, the power absorbed can be calculated, and either British or metric units of horse-power may be specified. At full torque the accuracy is within plus or minus 1%.

The torque dial and speed dial are normally fixed to the standard panel which is itself flexibly attached to the dynamometer bedplate. The torque dial is supplied with 20 ft of small-bore piping, so that users can fit it remotely from the dynamometer if they wish; the tachometer is of the electric type, and extended wiring to such a remote station will not affect its accuracy. By fitting the tachometer generator at alternate ends of the shaft, the dynamometer can be used for engines running in either direction of rotation. For quickly checking the accuracy of torque readings, lever arm and dead-weights can be supplied.

Three sizes of brake and dynamometer are at present available, ranging from 25 hp. at 4600/6000 rpm to 100 hp. at 2500/4000 rpm.



Two Heenan & Froude IE dynamometers, the one on the right fitted with torque arm

Pneumatic Cylinders and Valves

A variety of pneumatic equipment is now available, most of it on the unit principle and readily applicable to a great variety of purposes. Notes on unit types are given here and some typical tubular capacity data.

DURING recent years there has been much expansion of the use of pneumatic power in industry, mainly due to advances in the design of cylinders and valves. Fundamentally, pneumatics is usually applicable wherever there are operations involving straight line movement with either thrust or pull, or semi-rotary motion. It may be desired to vary the force available by simple knob adjustment or to vary the speed of operation within wide limits, using similar means. Perhaps there may be a need for remote control, effortless manual operation or a fully automatic pneumatic or electro-pneumatic system. All or any of these requirements, together with the benefits of cleanliness and ease of installation, provide a case for the use of pneumatics.

Cylinders

Now the focal points in a power circuit being the air cylinders, let us quickly review some interesting facts:

The choice of an air cylinder is generally governed by the following three considerations:

(1) Applied force.
(2) Direction or path and distance through which force is exerted.
(3) Speed and frequency of movement.

For instance (1) will decide its size, (2) the type of mounting and piston rod size (very often long stroke thrusting cylinders are subjected to a buckling load on the piston rod, and an oversize rod must be fitted), and (3) if port size is sufficient and if frequency of reversal (where high speed and inertia absorption of moving parts matters) merits a cushioned cylinder. It can be said, however, of (3), that air cylinders in this category form a small proportion of the general application.

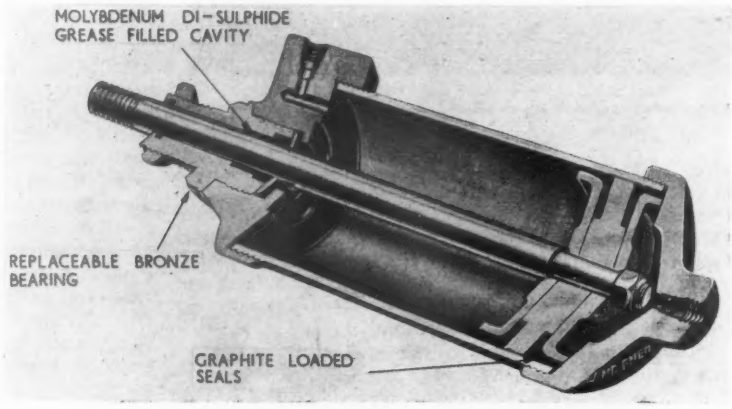


Fig. 1. Sectional view of double acting neck mounted non-cushioned cylinder.

Principles of air cylinder construction are more or less basic, and hence the choice of materials used therein is flexible only to a small degree: stainless steel which is of high strength, and will withstand corrosion, for the piston rod; hard drawn brass or copper tubing for the barrel; and cast gunmetal or aluminium for the end covers. Even so, improvements continue, perhaps the best known being the cushioned cylinder. With this, in addition to the normal porting there is a built-in flow valve and check valve in each end cover, so that the degree of cushioning may be varied to suit each individual requirement. An example in the improvements in non-cushioned cylinder design may be seen from Fig. 1, which shows a double acting neck mounted cylinder. In this case the piston rod has a replaceable bronze bearing which has a molybdenum disulphide grease-filled cavity and also, at its extreme end, a wiper seal. The piston cup seals and rod seals are graphite loaded to reduce friction and wear.

Basically, air cylinders fall into two categories:
(1) Single acting
(2) Double acting

and these in turn are sub-divided as follows, according to which type of mounting is required:
(a) Neck mounted.
(b) Flange mounted.
(c) Base mounted.
(d) Trunnion mounted.

Examples are shown in Figs. 2 to 5. There are also, to some extent, variations of the above, i.e. front, rear or centre trunnion mounted, double neck mounted, etc. Single acting cylinders with spring return are usually of short stroke (due to the compression ratio of the spring), and are often used for clamping purposes on tooling set-ups. A single acting cylinder without a spring is not subjected to this limitation and may be designed to push or to pull as desired, using other means for returning the piston rod.

Oil-air cylinders

When a precise rate of movement of piston rod is required, such as one would expect when applying an air cylinder to, say, a drilling machine feed or the feed in the workslide or turret of a lathe, an oil dashpot cylinder must also be used. Air, being an elastic medium, cannot be held to such precise requirements and the usual answer is to have an

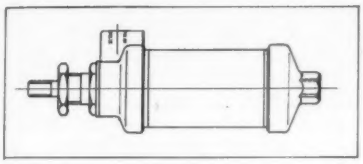


Fig. 2. Double acting neck mounted air cylinder.

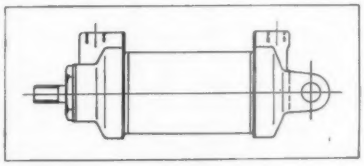


Fig. 3. Double acting rear trunnion mounted air cylinder.

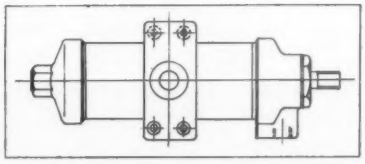
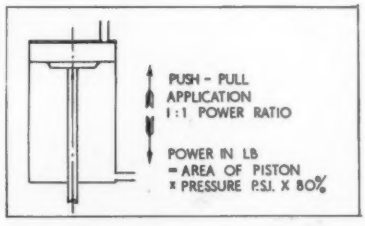


Fig. 4. Double acting centre trunnion mounted air cylinder.

air cylinder and oil cylinder working in tandem. The ports of the oil cylinder are connected to each other through a small reservoir fitted with a non-return valve, this making up for oil loss. The piston rods are connected together and the strokes of the cylinders must obviously be the same. Pneumatic manufactuers, however, make a special tandem cylinder for such a purpose as and when requested.

Table I.—THEORETICAL FORCE DELIVERED BY AIR CYLINDERS



(For practical purposes take 80% of figures given).

Cylinder bore	Piston area	40 psi	60 psi	80 psi	100 psi
in.	sq in.	lb.	lb	lb	lb
1¼	1·77	71	106	142	177
2¼	3·98	159	239	318	398
3	7·07	283	424	565	707
4	12·57	503	754	1005	1257
5	19·63	785	1178	1571	1960
6	28·27	1131	1696	2262	2827
8	50·26	2011	3016	4021	5026
10	78·54	3142	4712	6283	7854
12	113·10	4524	6786	9048	11310
14	153·94	6158	9236	12315	15394

Power and air consumption

Most people intending to use air equipment usually want to know about power and air consumption. For the economic use of compressed air much of the answer to this problem lies with the user if simple mechanical design principles are not overlooked. When using air cylinders a system of levers or toggles (according to the final movement required) should always be investigated. A system of levers will often provide the required movement with much smaller cylinders than would be necessary using direct action. Where only a very small final movement is to be imparted but the force must be great, toggle levers will give the highest mechanical advantage and require a relatively small air cylinder. Table I gives tabulated figures for various sizes of air cylinders at different pressures where it will be noted that for practical purposes it is advisable to work on 80% of the theoretical figure. This takes into account a power loss due to pipe friction, piston and piston rod friction. As power is related to cylinder diameter and air pressure, so is air consumption, and an important point to remember is that compressor manufacturers always specify compressor output in free air per minute at a specific gauge pressure (usually 100 psi). To convert this figure to "compressed air" the formula

$$V = \frac{\text{free air delivery} \times 14{\cdot}7}{(\text{gauge pressure} + 14{\cdot}7)}$$

should be used. It is usual, however, to calculate "free air" consumption for the cylinders concerned so that this can be then related to the stated "free air" delivery, as given by the compressor manufacturer. The formula for calculation of cylinder "free air" consumption is as follows:

$$C = \text{piston area, in.} \times \text{stroke, in.} \times (\text{gauge pressure, psi} + 14{\cdot}7) \div (1728 \times 14{\cdot}7)$$

This gives the consumption in cubic feet of "free air" for each single stroke of the piston.

Table II is useful for reference, providing cylinder displacements for standard bores and strokes up to 12 in.

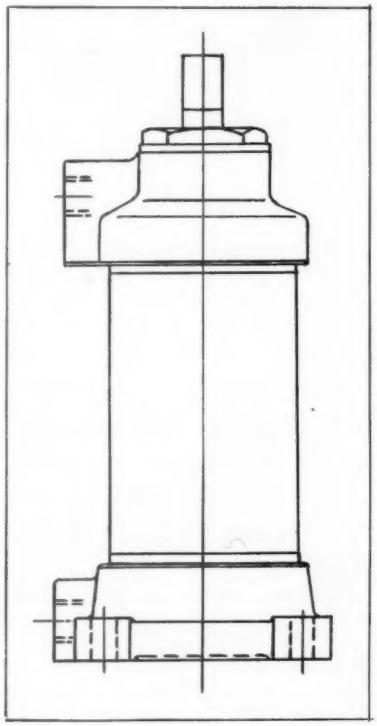


Fig. 5. Double acting base mounted air cylinder.

Valves and equipment

Generally speaking the basic features of valve design may be categorized as hereunder:

(a) Linear.
(b) Semi-rotary.
(c) Rotary.
(d) Poppet.
(e) Piston.

It is also quite usual to see a

Table II.—DISPLACEMENT OF AIR CYLINDERS

Cylinder dia.	1 in. stroke	2 in. stroke	3 in. stroke	4 in. stroke	5 in. stroke	6 in. stroke	7 in. stroke	8 in. stroke	9 in. stroke	10 in. stroke	11 in. stroke	12 in. stroke
in.	cu in.	cu in.	cu in.	cu in.	cu in.	cu in.	cu in.	cu in.	cu in.	cu in.	cu in.	cu in.
1	0·785	1·57	2·36	3·14	3·93	4·71	5·49	6·28	7·07	7·85	8·64	9·42
1¼	1·76	3·52	5·30	7	8·8	10·56	12·32	14	15·84	17·6	19·36	21·12
2¼	3·97	7·94	11·91	15·88	19·85	23·82	27·79	31·76	35·73	39·7	43·67	47·64
3	7·06	14·12	21·18	28·24	35·3	42·36	49·42	56·5	63·5	70·6	77·7	84·7
4	12·56	25·12	37·7	50·2	62·8	75·4	88	100	113	125	138	150
5	19·63	39·3	59	78·5	98·2	118	137	157	177	196	216	235
6	28·27	56·5	85	113	141	170	198	226	254	283	311	339
8	50·3	100	151	201	251	301	352	402	452	502	553	603
10	78·5	157	235	314	393	471	550	628	707	785	864	942
12	113	226	339	452	565	679	792	905	1018	1131	1244	1357

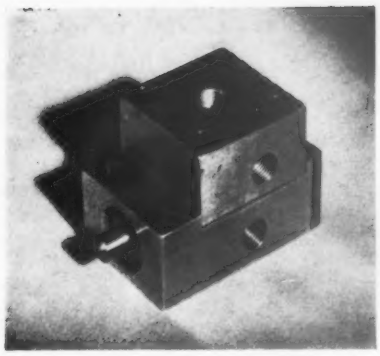


Fig. 6. Plunger operated pilot valve

whole range of valves using the same basic features of design, but having different modes of operation and application, this fulfilling an extremely wide variety of needs. This may be quite common where, for instance, a manufacturer has

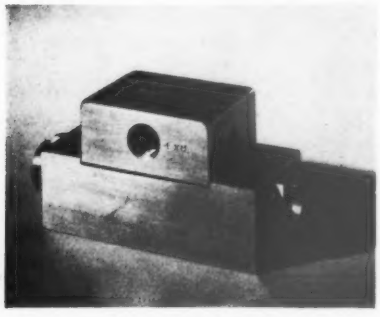


Fig. 8. Automatic valve

established a basic design principle proved for reliability, simplicity and economy. The number of ways in which valves may be operated is considerable, as can be seen from the lists which follow. The following may be termed basic methods.

(1) Hand (lever or pad).
(2) Foot.
(3) Cam or roller.
(4) Air.
(5) Solenoid.

From the foregoing list there are many variations and combinations giving an extremely wide choice of valves. For instance, we may again sub-divide those above as follows:

(a) Positive.
(b) Self-reversing.
(c) Self-exhausting.
(d) Hoist.

Incidentally both (c) and (d) are self-centring valves, but whereas with (c) in the central position the exhaust is open to atmosphere, in the case of (d) the exhaust is sealed as is common with all hoist type valves.

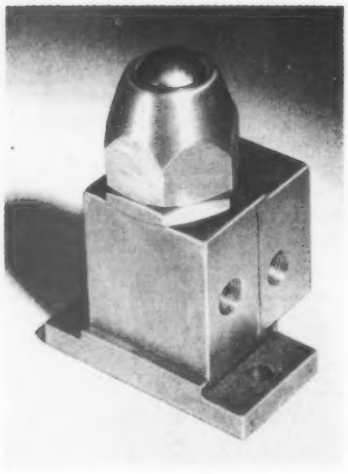


Fig. 7. Ball operated pilot valve

With (3) the valve may be cam or roller operated against a return spring, or alternatively may be supplied without a spring and air

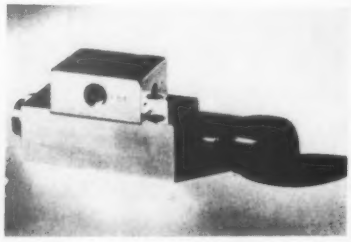


Fig. 9. Semi-automatic pad (hand) valve

pressure used to return it to its starting position; this also may be the case with (1) and (5). In the case of (4), which is an air operated valve, this could be positive, self-exhausting or hoist type. The foregoing, however, is merely by way of example to show the enormous number of combinations which may be obtained. Valve sizes may run from $\frac{1}{8}$ in. B.S.P. up to 1 in. B.S.P. ports, although those in more frequent use are up to $\frac{1}{2}$ in. B.S.P. The question of servo-operation or using pilot valves ($\frac{1}{8}$ in. B.S.P. is the pilot valve range) to operate bigger valves

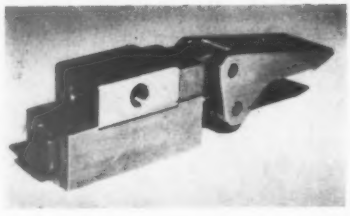


Fig. 11. Foot valve

is something which cannot be laid down by hard and fast rule. The advantages of servo-operation, such as economies in equipment and air consumption are fairly obvious and indeed for valve sizes of $\frac{1}{2}$ in. B.S.P. and above servo-operation is necessary—nevertheless policy should also be decided against the particular circuit under consideration.

From the preceding information it is therefore obvious that a forward trend in valve design is that of unit construction whereby an interchange of standard parts will give the combination and hence the particular valve desired. Figs. 6 and 7 show a plunger and ball operated valve respectively each using the same body. Figures 8 to 12 show automatic, semi-automatic, hand, foot and solenoid valves respectively.

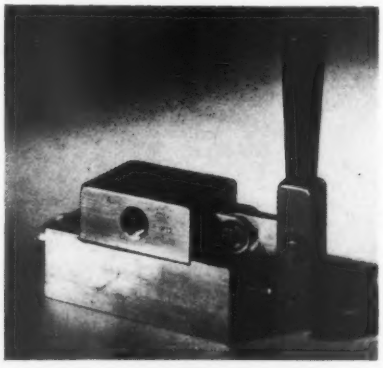


Fig. 10. Hand lever valve

Equipment

Under this heading can be listed copper pipe, solderless pipe fittings, elbows, tees, adaptors, etc., with which most engineers are familiar. It also covers a number of valves not included above because such valves are not concerned with directional flow control, so much as

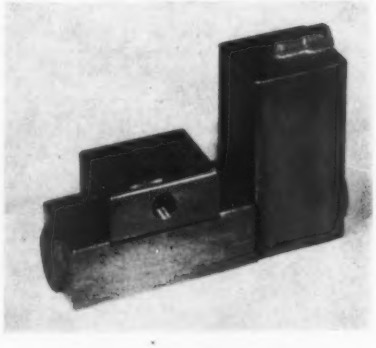


Fig. 12. Solenoid valve

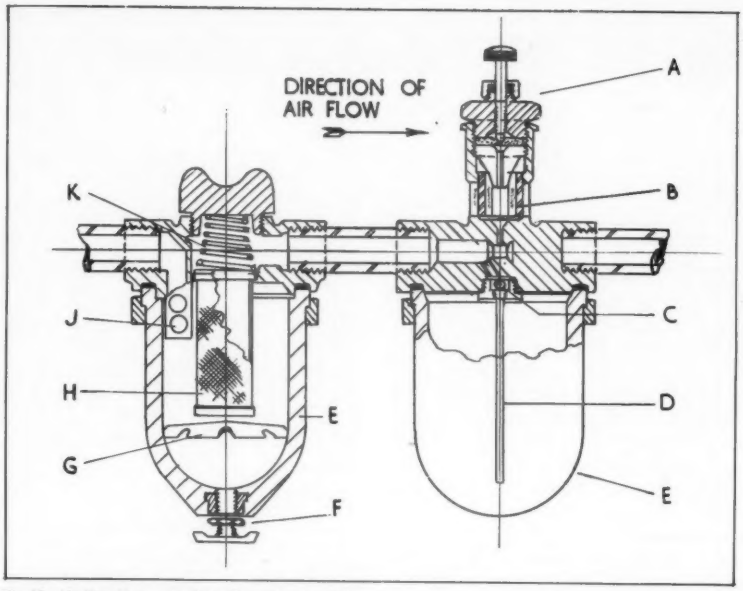


Fig. 13. Air line filter and lubrication unit. A, needle valve assembly. B, sight glass. C, check valve. D, syphon tube. E, transparent bowl. F, drain cock. G, baffle plate. H, filter. J, air inlets. K, spring holding filter

with pressure and air flow. In this category may be placed the relief valve, which will exhaust to atmosphere when pressure builds up above any pre-setting. Also the flow regulator which governs flow in one direction only, allowing full bore in the other direction, and the pressure reducing valve which functions as its name indicates. There are also the non-return valve, stop valve and shuttle valve, the latter being used when air is to be supplied in sequence to a common port from two different sources.

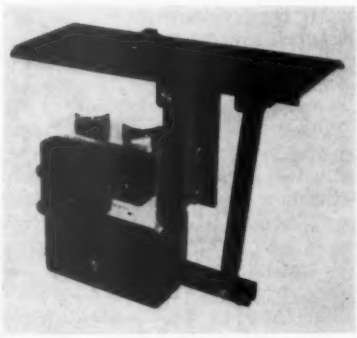
Lubrication and filtering of air

A good pneumatic system should have an entry of clean dry air (moisture removed) passing through some form of lubricator, which will supply air with atomized oil in the air stream. By doing this, valve and cylinder wear may be kept to its minimum. Various types of lubricator and filtering elements exist and a popular style is that shown in Fig. 13. In this air is filtered through a sintered metal element in the first container, picking up an oil mist by syphon action from the second container. The amount of oil mist can be varied as required, and is supplied only when there is air flow, thus giving lubrication proportional to the number of operations performed in the circuit.

Acknowledgment is made to Midland Pneumatic Limited, New Cross, Wolverhampton, for their kind permission to reproduce photographs and drawings.

Hydraulic Valve Design Simplifies Control Conversion

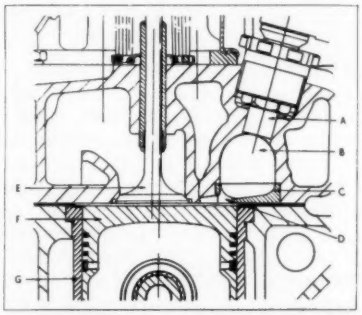
Simple conversion from manual to solenoid or cylinder control of hydraulic valves is featured in the design of the Ellison range of hydraulic valves which have been specially constructed to meet the many differing control requirements in hydraulic systems. The standard valves made by George Ellison Limited, Perry Bar, Birmingham 22B, can be operated by hand, foot, solenoid, air cylinder, air diaphragm or hydraulic cylinder at pressures of up to 2 ton/sq in. and for any number of ports up to five. All the well-known "Ellison" features for reducing maintenance to a minimum have been incorporated in the design, including self-honing seats and arrangements for preventing scoring of seats and stems.



One of the Ellison range of hydraulic valves for foot operation

The Combustion System of the Perkins Four 99 1.6 Litre Diesel Engine

In our January issue* brief reference was made to the combustion system embodied in the Perkins Four 99 1.6 litre diesel engine recently developed by F. Perkins Limited, Peterborough,



Section through the cylinder head. A, atomizer nozzle (pintle type). B, combustion chamber. C, combustion chamber insert. D, connecting port to cylinder. E, valve. F, piston. G, liner.

for agricultural duties. Details are now available of this new patented combustion system for which is claimed the promotion of complete combustion and maximum air utilization.

The upper part of the combustion chamber is machined hemispherical in shape, in the cylinder head, the lower half is formed by an inserted machined plug, which contains the throat or oval port connecting chamber to cylinder. Fuel is injected into the combustion chamber by means of a pintle type nozzle. During the greater part of the compression stroke, air is transferred into the chamber from the cylinder vertically upwards through the oval port, and produces swirl in the chamber, moving transversely across the nozzle. In the later stages of compression, the direction of air transfer is gradually changed from vertical to horizontal.

When combustion is about to begin, the final part of the air is transferred violently from the head, through the special-shaped passages machined in the head and chamber insert, horizontally into the combustion chamber to promote considerable turbulence in the mixture of fuel and air already present.

* January 1958 p.p. 40–41

Fault Location in Feeder Cables

Methods of testing for localization of faults in buried cables or in other types where visual examination is impossible.

WHEN investigating fault symptoms in electrical power plant, tests might indicate a failure of the supply to the plant due to a fault at a point somewhere in a lengthy feeder between a distribution board and the local isolating switch of the plant. Such a feeder might comprise either a multi-core lead-covered cable or several single-core cables run in conduit, and it then becomes necessary to locate the exact position of the fault so that a repair can be effected at a minimum expenditure of time and cost. The nature of the fault could be a break in one or more of the cables; a short-circuit between two or more of the cables; or an earth fault, i.e. a short-circuit between one of the cables and the lead sheath or conduit. A short-circuit or earth fault would be indicated if the distribution board fuses were blown, or the feeder circuit-breaker tripped on overcurrent under normal load conditions.

It is a simple matter to confirm the presence of an open-circuit or short-circuit by suitable continuity tests. When testing for an open-circuit all the cables should be connected together at one end, and continuity tests carried out between each pair of cables at the other end. In the case of a three-phase system, if continuity is indicated between one pair of cable ends only, then there is a break in the other cable; whilst if all three tests show lack of continuity there is a break in each of two or all three cables. When testing for an earth fault the cables should be isolated at both ends, and continuity between any of the cables and the earthed sheath or conduit will, of course, indicate the faulty cable. Similarly, with the cable ends isolated, continuity between any pair of cables indicates a short-circuit.

The location of the exact position of the fault necessitates further tests which may be carried out on the following lines,

Open-circuit fault

The simplest test consists of comparing the capacitance of the faulty cable or core with the capacitance of a sound core or cable in the same run. The equipment required comprises a battery of say 30 or 40 cells, a charge and discharge key, a two-way switch, and a ballistic galvanometer (an ordinary moving coil type instrument with a light "dead beat" movement is unsuitable). The test circuit arrangement is shown in Fig. 1, and with the switch in position A the key is depressed for a definite period of time, say 20–30 seconds. It is then released and the swing on the galvanometer noted. The operation is repeated with the two-way switch in position B. If the galvanometer deflexions are d_1 and d_2 respectively, L is the length of the sound core or cable, and X the distance of the fault from the end of the cable under test;

Then $L:X = d_1:d_2$ and

$X = L \times d_2/d_1$.

The result obtained should be checked by repeating the test from the other end. Where there is a break in all the cores or cables, tests must be made at both ends of one of the cores or cables. If then the galvanometer readings are d_1 and d_2 respectively, and X is the distance of the fault from the first end, then $X = L \times d_1/(d_1+d_2)$ where L is the total length of core or cable. Before making this test, a megger (insulation resistance) test of the cable should be carried out, as if the insulation resistance is seriously low, the test will be unreliable.

Another arrangement, known as the zero method, may be used and gives very satisfactory results. The principle is similar to that of the Wheatstone Bridge resistance test, and referring to Fig. 2, R_1 and R_2 are adjustable resistances and G is the ballistic galvanometer; the test being carried out as follows: Close switch 1, when the potentials V_1 and V_2 across the resistances will be such that $V_1:V_2 = R_1:R_2$. Close switches 2 and 3 together for, say, 30 sec when the faulty and sound cores will be charged to potentials V_1 and V_2 respectively; and if Q_1 and Q_2 are the charges given to the cores, $Q_1:Q_2 = V_1 \times X:V_2 \times L$. Open switches 2 and 3 and close switch 4 for 30 sec to allow the charges to mix. If Q_1 and Q_2 are equal, there will be no deflexion on the galvanometer when switch 5 is closed, and R_1 and R_2 must be adjusted until the desired result is obtained.

Then $V_1 \times X = V_2 \times L$ but

$V_1:V_2 = R_1:R_2$ therefore

$X = L \times R_2/R_1$.

In making these capacity tests, care should be exercised to ensure that all connections are highly insulated from earth and from each other.

Earth fault

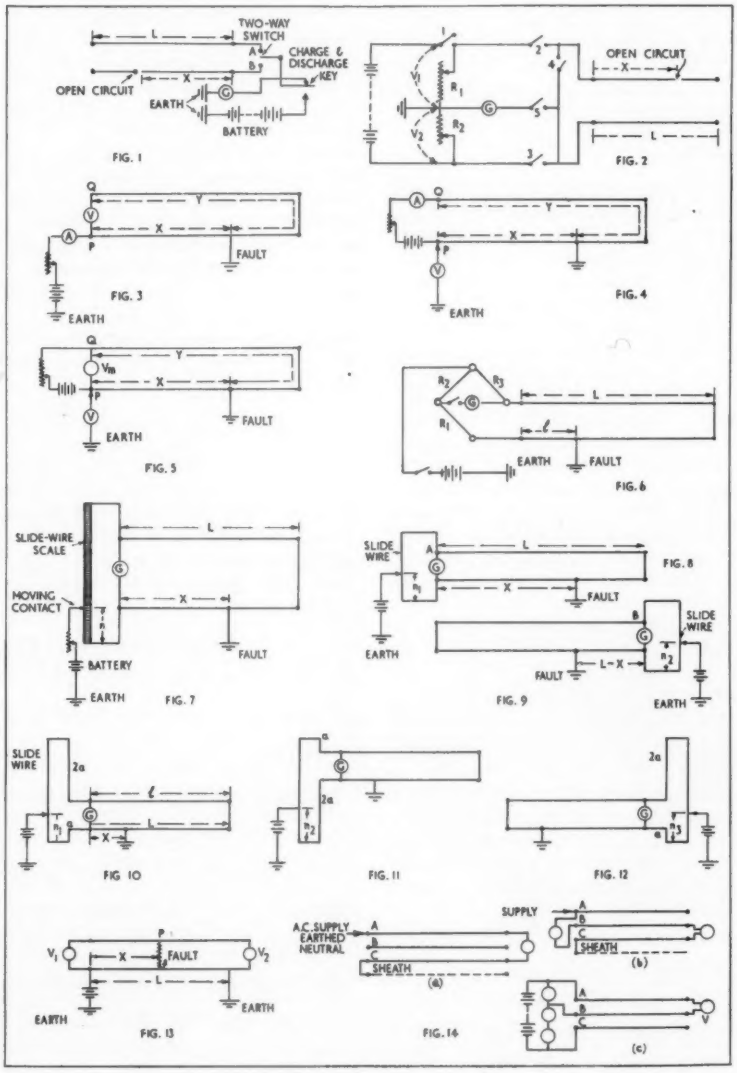
There are two commonly used methods of locating earth faults in cables, known respectively as (1) the fall-of-potential, and (2) the Murray loop method. Both methods compare the resistance to the fault with the resistance of a loop formed from the sound and faulty conductors, and determine the fault position by simple proportion. The essential difference is that Murray's loop test is a null test, capable of great accuracy, whilst the fall-of-potential test compares the readings of a millivoltmeter having limited accuracy. The Murray loop is therefore more suitable for very lengthy cables, but the fall-of-potential method can be used to advantage in the case of shorter cables.

Fall-of-potential tests

Consider the two cables in Fig. 3, one of which has a fault to earth but the continuity of which is not broken. The other cable is sound and after connecting them together at one end, testing current from a battery, and maintained at a constant value, measured by ammeter A, is passed first into the end P, giving an instrument reading V_1 on the voltmeter V connected to the ends of the cable loop; then into Q, giving a second reading V_2. Suppose that the resistance of the voltmeter is equivalent to K yards of the cable loop, and that

the fault divides the length of this loop L into two parts X and Y. If a current of, say 1 ampere passes into P, there are two paths for this current, one of resistance proportional to X direct to the fault, and the other of resistance proportional to $Y+K$ through the voltmeter. The voltmeter current will therefore be $X/(X+Y+K)$ or $X/(L+K)$. Similarly if 1 ampere is passed into Q, then, as the resistance of the two parallel paths are proportional to Y and $X+K$, the voltmeter current will be $Y/(L+K)$. If the voltmeter readings V_1 and V_2 are accurately proportional to the currents causing these readings, then $V_1/V_2 = X/Y$, so that $X = L \times V_1/(V_1+V_2)$, and the shunting effect of the voltmeter is eliminated.

An alternative method of making a fall-of-potential test is to pass a constant current round the loop as indicated in Fig. 4 and measure first the voltage drop V_1 between P and earth and then the voltage V between P and Q. If the current in the loop is 1 ampere, then, if there is no e.m.f. in the fault, the voltmeter current when connected to P will be $X/(X+K)$, for the 1 ampere will divide and flow in two parallel paths of resistances proportional respectively to X and K. When the voltmeter is connected to P and Q, the resistances of the parallel paths will be proportional to L and K and the voltmeter current will be $L/(L+K)$.



Figs. 1-14. Test circuits for fault location.

In this case the voltmeter currents are not proportional respectively to X and L, and if the readings V_1 and V are used in the simple formula $X = L \times V_1/V_2$, the calculated distance of the fault will be in error unless K is very large relative to L. Thus, suppose that the loop resistance is 6 ohms and the voltmeter resistance is 300 ohms, then $K = 50L$. V_1 will be proportional to $X/(X+K)$ or $X/(X+50L)$ and V to $L/(L+50L)$. If the true value of X is $0.2L$, or four-fifths of the length of the faulty cable, then $V_1/V = 51 \times 0.2/50.2 = 0.203$, and the result will be in error by about 1.5%. If the distance X of the fault is 500 yd, this error will correspond to 7.5 yd.

This source of error can be eliminated by modifying the test arrangements and procedure as illustrated in Fig. 5. Instead of the test current being maintained constant the voltage drop in the loop, as indicated by a second voltmeter Vm is maintained at a constant value by adjusting the rheostat in the battery circuit. If the measuring voltmeter is connected between P and earth to give a reading V_1, then the resistance of the loop in terms of cable lengths will be $Y+XK/(X+K)$ or $(XY+LK)/(X+K)$. The current in the loop with 1V at its terminals will be $(X+K)/(XY+LK)$, and the fall of potential in the section X of the loop shunted by the voltemeter of resistance $XK/(X+K)$ will be $XK/(XY+LK)$ and this will be the reading V_1 given by the voltmeter. If the voltmeter is then connected between Q and earth the resistance of the loop will be $X+YK/(Y+K) = (XY+LK)/(Y+K)$ and with 1 V drop in the loop the current will be $(Y+K)/(XY+LK)$. The resistance of the component shunted by the voltmeter will be $YK/(Y+K)$, so that the voltmeter reading V_2 will be equal to $YK/(XY+LK)$, and $V_1/V_2 = X/Y$ so that $X = L \times V_1/(V_1+V_2)$. Thus by maintaining a constant total voltage drop in the loop and by measuring the voltages of the two ends to earth, the shunting effect of the voltmeter is eliminated.

Murray's loop test

This type of test necessitates the use of a mains testing set incorporating a Post Office or other pattern Wheatstone bridge, in addition to a sensitive galvanometer; and Fig. 6 shows the arrangement of the test circuit, the battery earth connection being made to the lead sheath or conduit of the cable under test. The

bridge consists of three variable arms, R_1 and R_2 each having resistance values of 0, 1, 10, 100, and 1000 ohms, and R_3, 0–110 ohms in steps of one ohm. The galvanometer has a sensitivity such that a potential of about one millivolt will give a deflexion of one small scale division.

For the average type of factory feeders, varying say from 250 yd of 0.4 cable to 50 yd of 0.0225 cable, the bridge would be used under the following conditions: $R_1 = 0$, $R_2 = 10$, and R_3 variable.

When a balance has been obtained, i.e. there is no deflexion of the galvanometer upon pressing the key, the position of the fault is given by: $l = 2L \times R_2/(R_2+R_3)$ where L is the length of the cable run. This is only strictly true if the cables under test are connected directly to the bridge terminals. If it is necessary to use two leads of smaller diameter for connecting the cables to the terminals, then, if each connecting lead is of length d and cross-section S_1 whilst the cross-section of the faulty cable is S, then the distance of the fault from the end of the cable is given by:

$$l = 2L \times R_2/(R_2+R_3) - d[S/S_1 - 2R_2/(R_2+R_3)].$$

The connecting leads should be kept as short as possible, and it is also essential that the temporary connection of the two main cables together at the other end should have a low resistance compared with that of the loop, to avoid an error in the localisation of the fault.

The foregoing equations for the position of the fault apply only if the sound and faulty cables have the same cross-sectional area. In the event of the two cables differing in area, then the factor $2L$ would become;

$$L+L\left\{\frac{\text{area of faulty cable}}{\text{area of sound cable}}\right\}$$

$$= L\left\{1+\frac{\text{area of faulty cable}}{\text{area of sound cable}}\right\}$$

This is known as the total equivalent length of the loop. Thus, if there were two cables 120 yd long, the faulty one being 0.15 sq in. and the sound cable 0.1 sq in. area, then the factor $2L$ would be $120+120(0.15)/(0.10) = 120+180 = 300$ (instead of 240 for two cables of the same cross-section).

The slide wire bridge

Probably the most frequently used method for locating the straightforward fault is that employing a slide-wire bridge. This comprises a length of wire suitably mounted on a hardwood base and soldered to terminals so that it can be connected across the two cable ends forming the loop to be tested. A convenient length of wire is one metre, and a moving contact sliding on a rod connects the wire to the battery as shown in Fig. 7. The distance of the sliding contact from the end of the wire connected to the faulty cable is read off directly in millimetres on a scale placed under the wire. If this reading is n, then the distance of the fault is given by $X = 2L \times n/1000$, where $2L$ is the loop, i.e. twice the length of the cable run.

Inaccuracy may be experienced in testing short runs of cable due to errors caused by the unknown resistance of leads connecting the slide-wire to the cable loop. This occurs where these leads are included in the slide-wire branches by connecting the galvanometer to the slide-wire terminals.

If the two cables forming the loop are of equal length and cross-section, the error due to the connecting leads can be eliminated by making two tests with the connections shown in Figs. 8 and 9 respectively. If L is the length of the faulty cable, X the distance of the fault from the end A, and K the length of slide-wire equal in resistance to that of each of the similar connecting leads, then testing for balance with the slide-wire at end A of the cable as shown in Fig. 8, and assuming that the length of the slide-wire is 1000 millimetres, we have: $X/2L = (n_1+K)/(1000+2K)$, where n_1 is the distance of the sliding contact (in millimetres) from the end of the slide-wire connected to the faulty cable, since the total equivalent length of the slide-wire is increased by the leads to $(1000+2K)$ millimetres, and the distance of the sliding contact from the end of the faulty cable is similarly increased to (n_1+K) millimetres.

A second test is made at the other end of the cable as shown in Fig. 9. If the distance of the sliding contact from the end of the slide-wire connected to the faulty cable is n_2, then similarly,

$$(L-X)/2L = (n_2+K)/(1000+2K)$$

Adding the two equations, we have

$$(n_1+n_2+2K)/(1000+2K) = \tfrac{1}{2}$$

so that $K = 500-(n_1+n_2)$ and

$$X = L \times \frac{500-n_2}{1000-(n_1+n_2)}$$

a formula from which the unknown quantity K is eliminated. It will be noted that if $K = 0$, (n_1+n_2) will equal 500, and the formula reduces to the well-known expression

$$X = Ln_1/500.$$

If it is required to carry out an earth fault localisation test where the two lengths of cable are of unequal cross-sectional area in addition to eliminating any possible error due to the resistance of the leads connecting the slide-wire to the cable loop, three separate tests should be carried out, as illustrated in Figs. 10, 11, and 12.

The two connecting leads must be such that one has twice the resistance of the other, and these leads are marked a and $2a$, their equivalent lengths in terms of the slide-wire. In the first test (Fig. 10) the short lead is connected to the faulty cable, and let n_1 represent the distance of the sliding contact from the end of the wire connected to this cable, in millimetres. In the second test shown in Fig. 11, the long lead is connected to the faulty cable, and let n_2 be the distance of the contact for balance under these conditions. The third test is carried out at the other end of the faulty cable with the connexions otherwise as in the first test (see (Fig. 12); let n_3 be the distance of the movable contact for balance in this case.

If L stands for the length of the faulty cable, l for the equivalent length of the sound cable which completes the loop, and X the fault distance, then, as the virtual length of the slide-wire is increased by a millimetres at one end, by $2a$ at the other, the first two tests lead to the equations:

$$X/(L+l) = (n_1+a)/(1000+3a) \quad \text{and}$$

$$X/(L+l) = (n_2+2a)/(1000+3a)$$

from which $n_1+a = n_2+2a$ and $a = n_1-n_2$.

The third test leads to the equation:

$$(L-X)/(L+l) = (n_3+a)/(1000+3a)$$

which combined with the first gives:

$$X/(L-X) = (n_1+a)/(n_3+a) \quad \text{and}$$

$$L/X = (n_1+n_3+2a)/(n+a)$$

Substituting the value of a we obtain:

$$X = L \times (2n_1-n_2)/(3n_1-2n_2+n_3)$$

in which formula the unknown quantities are eliminated.

Short circuit fault

Line-to-line faults where two conductors are in contact but insulated from earth can readily be located by fall-of-potential methods. One of the faulty but continuous conductors is earthed at the far end (see Fig. 13) and the test current passes through the loop formed by one conductor and the cable sheath or conduit.

The falls-of-potential V_1 and V_2 are measured at the two ends of the cables and the position of the fault is given by: $X/2L = V_1/V_1+V_2$.

Should the test result prove inaccurate, it may be due to stray e.m.f.s, and this difficulty can usually be overcome by taking a second set of readings with the battery (and resultant voltmeter readings) reversed. The correct fault position is then:

$$X = 2L \times \frac{\text{mean of } V_1}{\text{mean of } V_1 + \text{mean of } V_2}$$

where L is the route length.

If the continuity of the sheath or conduit is poor the test current will be restricted, and under these conditions the interchange of the battery and voltmeter may give better results.

If one of the conductors is burnt through at point P, a modified test can be carried out by measuring V_1 and comparing it with the calculated potential drop per yard of cable, and in this case a correction may be required for the effect of the fault resistance in series with the voltmeter.

$$\text{Distance to fault in yards} = \frac{V_1}{\text{Potential drop per yard}} \times (1+f/R)$$

where f = fault resistance and R = voltmeter resistance.

This method can also be used as a check on an indicated position, or where the route length is in doubt.

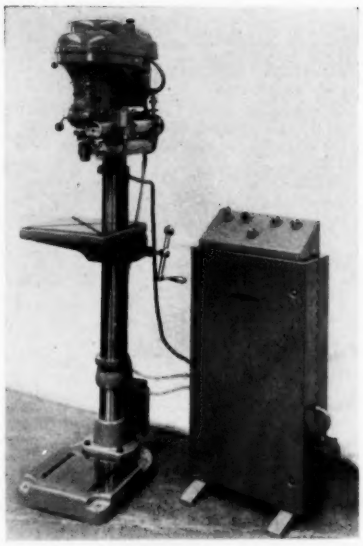
Identifying cable cores or conductors

Under certain circumstances it may be necessary to identify the ends of the respective cores of a cable or of separate cables in a lengthy conduit run, and there are several methods whereby this may be achieved by means of a single test. The simplest method is that shown in Fig. 14(a). This is convenient when a supply with an earthed neutral is available at one end of the cable. It is seen that one conductor is made alive to the supply, another is connected to the sheath or conduit, and the third is left isolated. The conductors can be identified at the far end by means of a test lamp. Full voltage on the lamp identifies conductors A and C, and of these A is the one which gives full voltage to the sheath or conduit, all three conductors being thus identified.

There is, however, a drawback to this method in that the continuity of the isolated conductor is not established. A better, but slightly more complicated test, is the one illustrated in Fig. 14(b). In this case, as before, one conductor is made alive, and another is joined to the sheath or conduit, while a lamp is connected between the live and the third conductor. When tested with a lamp at the far end, full voltage on the lamp establishes the identities of conductors A and C, whilst a positive continuity test of conductor B is obtained by the circumstance that half voltage on the test lamp is obtained between this conductor and C.

The third method of testing is shown in Fig. 14(c), and this method is useful when the testing voltage is from an unearthed supply. In this case the full voltage is applied between two conductors, and the third conductor is made alive from a one-third tap on a set of three lamps in series also connected to the supply. The test at the far end is made with a voltmeter, and the conductors are identified by the circumstances that full voltage is obtained between A and C, one-third voltage between A and B, and two-thirds voltage between B and C. When adopting this method of test, it is advisable to take to the testing position a sketch of the connexions at the end at which the cable is made alive to avoid any possibility of error in carrying out the test.

AIR REGULATOR.—Suitable for air pressure regulation from 160 psi, this ¾ in. B.S.P. manifold valve S F 1169 manufactured by Lang Pneumatic Limited, Birmingham Road, Wolverhampton is housed in a gunmetal body. The pressure reducing valve is operated by a large synthetic rubber diaphragm giving extreme sensitivity. Other features include stop valves on both inlet and outlets, needle valve flow regulation, and non-return for protection in the event of an air failure



Drilling machine with Pacera feed unit and control console

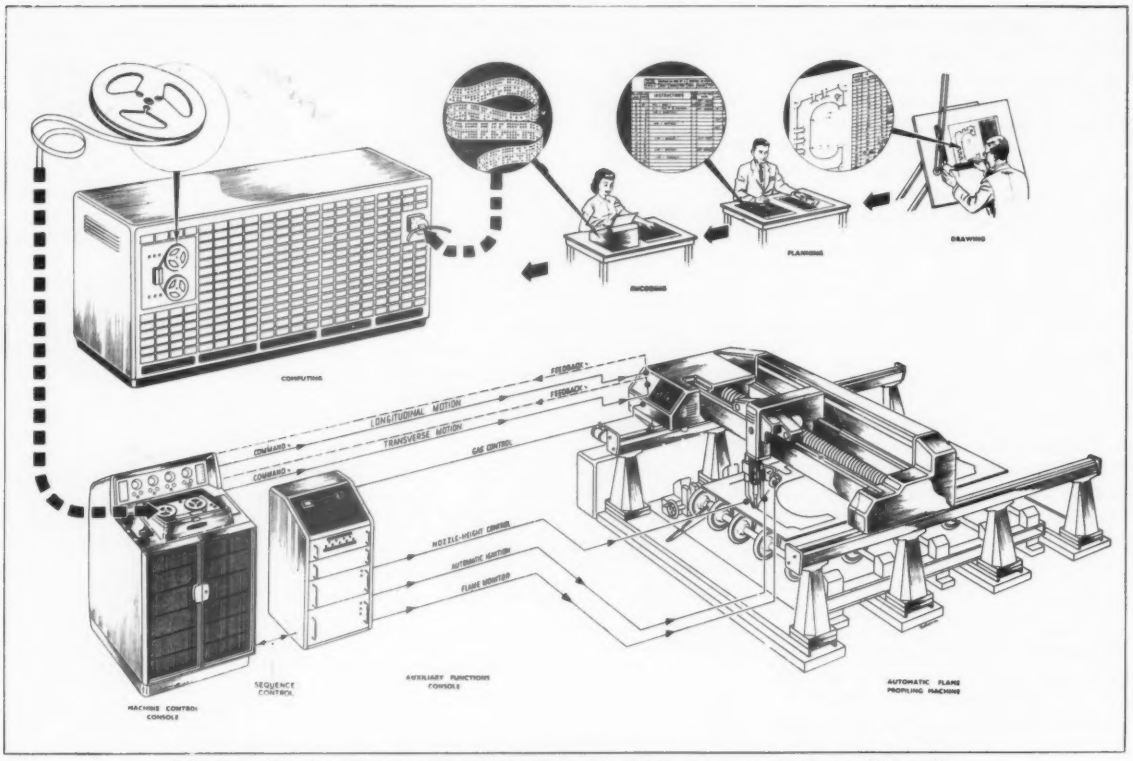
Deep Hole Drilling with Incremental Feed

Specially designed for use with existing drilling machines when the drilling of deep holes is required the Pacera incremental drill feed equipment provides periodic drill withdrawal from the work to overcome the increased resistance to the drill as the depth of hole increases and the accumulation of swarf.

With the equipment illustrated the progressive forward movement of the drill and its periodical retraction are controlled by an electrical cyclic timer with variable controls. The periods during which the drill either feeds or retracts are independently variable over the range 1·5/60 sec (other ranges available if required).

This method of drill relieving employs a special air hydraulic feed unit, which provides fast approach and fast retraction of the drill during the complete drilling cycle; it also allows exactly the right cutting speed to be chosen for the drill in use.

The Pacera deep hole drilling kit made by W. J. Meddings Limited, Slough, Bucks., comprises a special air hydraulic feed unit, controlled by a fourway solenoid operated valve. A separate control console containing the cyclic timer, interlocking relay, transformer, etc., for connexion to the machine by flexible cable connectors. An isolator is fitted and the kit includes a lubro control unit.



Schematic outline of programme stages and control elements related to the automatic flame profiling machine.

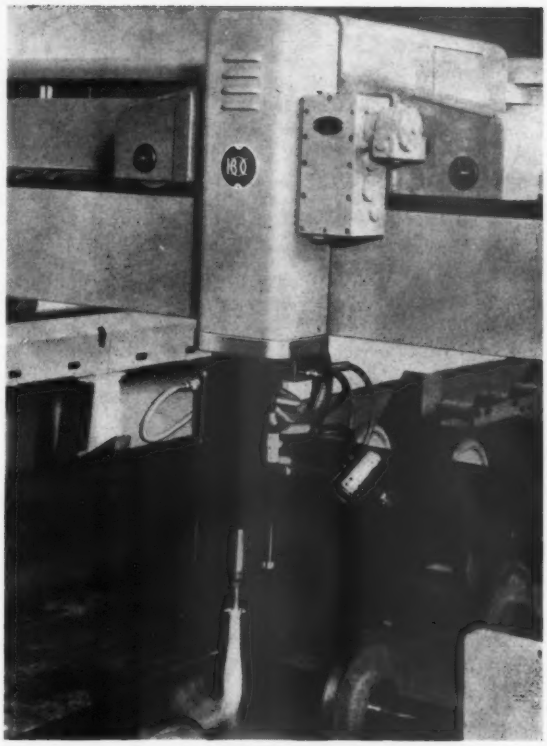
Computor Controlled Flame Profiling

The successful addition of a programme controller to a flame cutting machine promises high precision in the production of cut plates directly from data supplied by the design office. The machining instructions are embodied in a magnetic tape which can be preserved for use at any time.

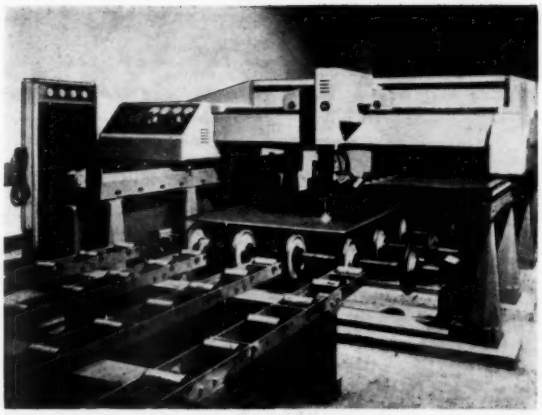
THE joint researches of British Oxygen Gases Limited and Ferranti Limited into the computor control of flame cutting machines have resulted in a successful experimental machine and, as a first application, a completely new system of cut- and profiled-plate production for shipyards and a design for a production machine with a capacity for cutting plates up to 12 ft by 40 ft, port and starboard, one on each side of the machine. This is a first development in a field which encompasses all those branches of heavy engineering which are concerned with the fabrication of steel plate—a field which, besides shipbuilding includes marine and structural engineering, locomotive building, the making of boilers, tanks and other forms of pressure vessels, carriages and wagons, earth moving equipment and heavy agricultural machinery, as well as many applications in the atomic energy programme.

The conventional route from drawing board to the actual cutting of the plate in current shipbuilding practice in this country is via the tables of off-sets, the mould loft, scrieve board, marking-out bench and machine templates. Each of these stages is capable of introducing errors, significant in cost and perhaps affecting accuracy of the finished structure. Computor controlled cutting eliminates the need for many of the conventional stages between the drawing board and the cutting machine. The machine receives its instructions from a magnetic tape, and operation thereafter is entirely automatic as to shape, correction of error and monitoring of the services supplying the cutting machine.

In practice, the part to be profiled is designed and drawn in the conventional manner except in that in place of dimensions specified as lengths between points, all dimensions are given as co-ordinates relative to the axes about which the machine works. A planning sheet is prepared from the drawing which gives the input information for the computor in human terms and includes such details as required cutting speed, kerf width, pre-heat time, and so on; it also includes the data regarding points of change and types of curve from the drawing in the order in which the profiling operations are to take place. When the planning sheet is complete,



Tranverse carriage and cutter head showing, from left to right, nozzle height sensing probe, cutter, ignition electrode, and flame monitoring unit.



Front view of experimental flame profiling machine incorporating a simplified version of a plate handling roller table.

Tape control console and auxiliary functions console. The tape deck lid is raised and three trays are partially withdrawn. Each tray contains six card type circuits. The underside of one of the chassis in the auxiliary functions console is displayed.

every movement necessary to produce the part has been specified.

The information on the planning sheet is then coded so as to be in a form suitable for use as input to the computor. A teleprinter is used for this purpose and copy-typing only is involved. The product from this machine is a paper strip with a pattern of holes, the number and position of which correspond to the code. It also produces typed information so that this may be cross-checked with the planning sheet. The information on the paper tape is read by the computor which produces from it a magnetic tape for use in the control console of the cutting machine.

It is not necessary for any manufacturer using automatic flame cutting to own a computor. A centralized computor service is available and users can purchase time on this as required. In operation, coded paper tapes will be sent to the computor centre by shipyards, who will receive back reels of magnetic tape carrying all the instructions for use in the control console connected to the profiling machine on a 24-hour service.

A control console is necessary for each profiling machine. The operating procedure after insertion of the magnetic tape is to locate the centre of the cutting nozzle at the datum position which will normally be the origin of the system of axes used in planning, with the workpiece located against stops which are fixed in relation to the datum. This being done, the machine can proceed under the control of the magnetic tape alone and no human intervention is necessary thereafter. In addition to the positional monitoring along the axes, other control elements are included to cover requirements peculiar to the flame cutting process. These are:—

1. Continuous nozzle height sensing in order to preserve the correct distance between the cutting nozzle and the plate.
2. A flame monitoring unit to confirm the presence of a pre-heat flame (which, in the event of failure, will automatically shut down the system and stop the machine. A restart sequence can be initiated immediately in these circumstances.)
3. An automatic ignition system for lighting the gases on receipt of the command impulse from the magnetic tape.

Lastly, there is an automatic continuous monitoring of the performance of the control unit so that if for any

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cause, such as supply or component failure, some part of the equipment ceases to function, the machine will shut down before any damage is done to the work.

The machine which has been developed for carrying out experimental work on automatic flame profiling is restricted to square cuts on plates up to 6 ft × 7 ft in size with a maximum thickness of 2 in. It is a small portal type machine with a single nozzle, and an elementary work table area comprising three distinct sections for the loading, cutting and discharging of the work-piece. The main features of what will later become the production machine are incorporated in this initial model, including computor control of both axes of motion of the machine, height sensing, flame monitoring, and a balanced gas control system.

4 MeV Linear Accelerator

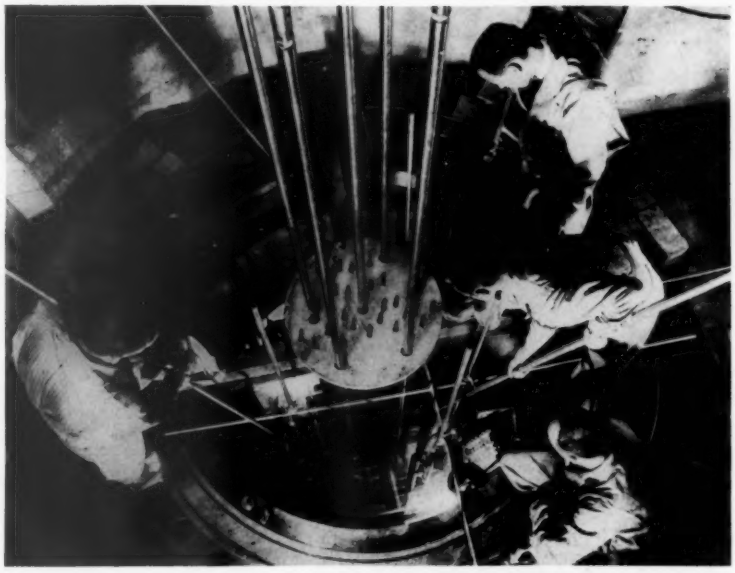
The 4-million electron-volt linear accelerator ordered by British Petroleum Limited for their research station at Sunbury-on-Thames, Middlesex, is believed to be the first machine of its kind in the country to be built specifically for industrial research in the petroleum and chemical industries.

The accelerator provides a compact, easily-controlled source of high-energy electrons, deep-penetration X-rays or neutrons, the last two being produced by causing the electron beam to hit a suitable target. The machine is of the travelling-wave type, using radio frequency power generated by a magnetron valve operating at a frequency of 3000 Mc/s. Mean electron energy is 4·0 MeV, and mean electron output 800 watts at 500 pulses per second. Pulse repetition frequency is variable between 100 and 500 pulses per second. Maximum X-ray output using a tungsten target is 700 roentgens per minute at 1-metre distance from the target.

A special building embodying adequate protection for the staff against radiation is being constructed to house the unit. The compact dimensions of the trolley mounted machine—it measures only 6 ft long, 2 ft 3 in. wide and 6 ft 3 in. high—and the ease with which it can be installed have simplified the requirements of the building considerably.

Design and construction of the accelerator and its associated control equipment are being undertaken by Mullard Research Laboratories on behalf of Philips Electrical Limited, the contractors.

In chemical processing, electron irradiation is recognized as probably the most efficient method of initiating polymerisation and other chemical reactions, and of producing new materials by molecular re-arrangement or graft techniques. For non-destructive inspection, the linear accelerator makes possible the examination of steel many inches thick by the radiographic method.



FUELLING A REACTOR.—Fuel elements being loaded into core of General Electric Company's Vallecitos developmental boiling water reactor which is producing steam for the United States first all privately-financed atomic power. Steam produced was supplied to a 5,000 kW turbine generator installation built by the Pacific Gas & Electric Company. Electricity produced was fed into PG&E transmission system for use in northern and central California. The plant was completed in a year and five months

Nuclear Plants for Italy

The first of the nuclear power stations to be built in Italy by The Nuclear Power Plant Company Limited will have an output of 200 MW. The company will be responsible for the overall design and satisfactory commissioning of the station while an Italian concern, AGIP Nucleare, will place all local contracts and will carry out the site erection.

The arrangement between The Nuclear Power Plant Company Limited and AGIP Nucleare, a subsidiary of Ente Nazionale Idrocarburi, of Rome, is for the construction of nuclear power stations in Italy and long-term co-operation on the design and development of power reactors of the gas-cooled type. The first Italian station will involve the manufacture of considerable quantities of plant in the United Kingdom, but as Italian knowledge of the special plant grows so will that country's participation in manufacture increase.

The single reactor for the first Italian station will be of the same overall dimensions as one of the two 150 MW reactors at the Bradwell-on-Sea, Essex, station on the construction of which The Nuclear Power Plant Company Limited is at present engaged. The increase in output is a reflexion of the research and development that has taken place since the Bradwell design was accepted a year ago.

Reactor Construction in U.S.

The annual progress report of the Atomic Industrial Forum on developments in commercial applications of atomic energy in the United States, shows that during 1957, the U.S. atomic industry completed the construction of 16 nuclear reactors, including seven power-type reactors and nine research and test reactors, for both private and governmental purchasers in the U.S.

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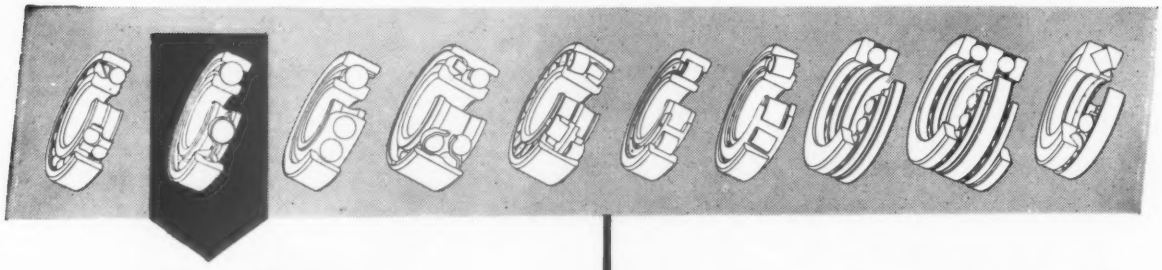

Illustrated here is the single row deep groove ball bearing, the most widely used of the ten variants of the four basic types of ball and roller bearing made by The Skefko Ball Bearing Co. Ltd.

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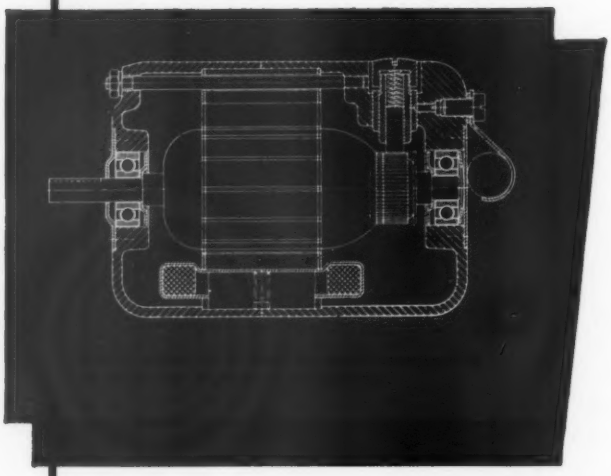

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and abroad. The power-type reactors include those designed for naval ship propulsion and for prototype and demonstration power plants. In addition to these projects, construction was begun or continued on 59 reactors, 35 of which are power-type reactors and 24 research and test reactors, and orders were placed for the manufacture of 10 new reactors—5 for the production of electric power and 5 for research and test purposes.

Also in the past year, American industry signed contracts for the construction of seven uranium ore processing mills, 13 companies announced plans to enter the field of nuclear fuel element production and research, one company began construction of a privately owned feed materials plant, three companies completed construction of plants for the production of zirconium, and two companies completed construction of plants for the production of beryllium.

books

Design Data for Rubber Components.—The Research Association of British Rubber Manufacturers has released its Research Report No. 84, by A. R. Payne, on "Shape Factors and Functions in Rubber Engineering". The effective stiffness of a rubber component can be expressed as the product of three quantities: the elastic modulus of the rubber, the degree of compression, and a 'shape function' depending solely on the geometrical configuration of the component. Hitherto the shape function has been represented by a confusing variety of arbitrary factors. The report, however, develops methods by which it can be calculated directly from the dimensions; and this has been worked out for cylinders, rectangles, etc. (with or without bonded ends) used in compression, and for various forms of mountings used in shear or in a combination of shear and compression. Thus the data and methods given in the report present a simple and logical means of calculating the force/deformation relationships for most of the commonly used forms of component, given the one basic property of elastic modulus, either static or dynamic according to the type of deformation encountered in service. Copies of the report can be obtained, while present stocks last, from the Research Association of British Rubber Manufacturers, Shawbury, Shrewsbury, Shropshire. The price to non-members of the Association is one guinea.

European Economy.—According to the latest edition of the United Nations Economic Commission for Europe's "Economic Bulletin for Europe" (H.M.S.O., 3/9 net) the present economic situation in Europe is characterized by a slackening in the rate of growth of production in both Eastern and Western European countries. The writers of the bulletin suggest that, while the necessity of the September measures in the United Kingdom in order to protect the foreign exchange reserves cannot be called in question, the contribution which a continuation of such restrictive policies can make to the solution of the basic balance-of-payments problems is open to some doubt, and the measures seem to point to a stagnation of investment, including productive industrial investment, if not to a decline. The state of business seems likely to be depressed and the success of the measures in relieving wage-induced inflation depends to a large extent on the sensitivity of the trade unions to changes in the level of activity.

Soldering Aluminium.—The latest bulletin in the series issued by The Aluminium Development Association gives precise instructions for soldering aluminium and its alloys by all the known methods. Information is given on solders and fluxes and there are notes on finishing, embrittlement and corrosion testing. A useful feature is an appendix showing where to obtain suitable solders and fluxes. The book is concise and practical and will be invaluable wherever aluminium is soldered by whatever method and on any scale. It is obtainable, price 2/-, from the A.D.A. offices at 33 Grosvenor Street, London W1.

Bibliography on Adhesive Bonding of Metals.—A selected list of over 150 annotated references to books and magazine articles published from 1947 to 1957, covers all aspects of adhesive metal-to-metal bonding, including references to theory, technology, properties and methods of application. In addition to application in the aircraft industry, the references deal with many other products such as tools, machinery parts, electrical apparatus and wiring, pistons, metal window frames, furniture, bicycles, etc. This "ESL Bibliography No. 12" may be purchased from the Engineering Societies Library, 29 West 39th Street, New York 18, N.Y. Price $2.00.

Gauge and Tool Makers.—The handbook of the Gauge and Tool Makers' Association sets out the aims and objects of the association, lists the officers, and serves the useful purpose not only of providing the full names and addresses of the members, but also a complete directory of their products arranged for ready reference. Copies are available free to actual and potential buyers of tools and gauges. The address of the association is: Standbrook House, 2/5 Old Bond Street, London W1.

A.D.A. Publications.—A booklet available free from The Aluminium Development Association, 33 Grosvenor Street, London W1, gives details of the main series of technical publications issued by the association. Certain publications, now available on loan only, are listed separately.

New Standard

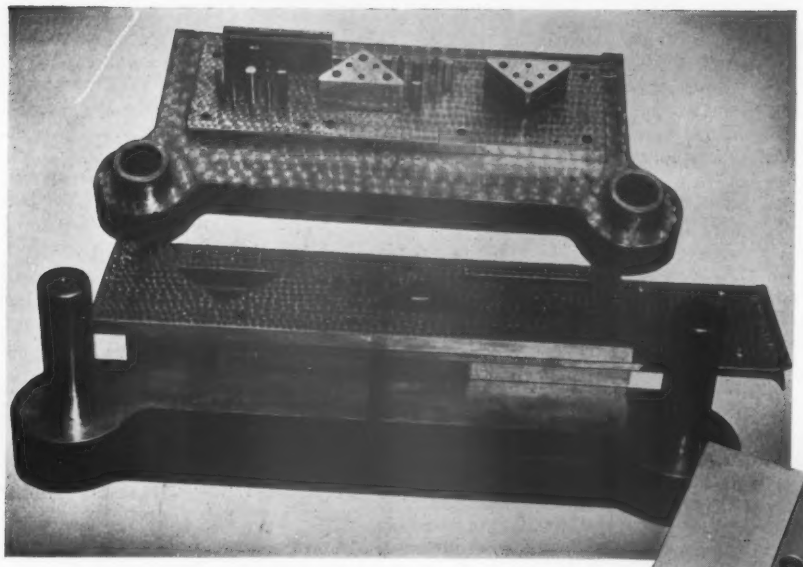
Nyvin type electric cables for aircraft (B.S. E.24:1957). Price 7/6.

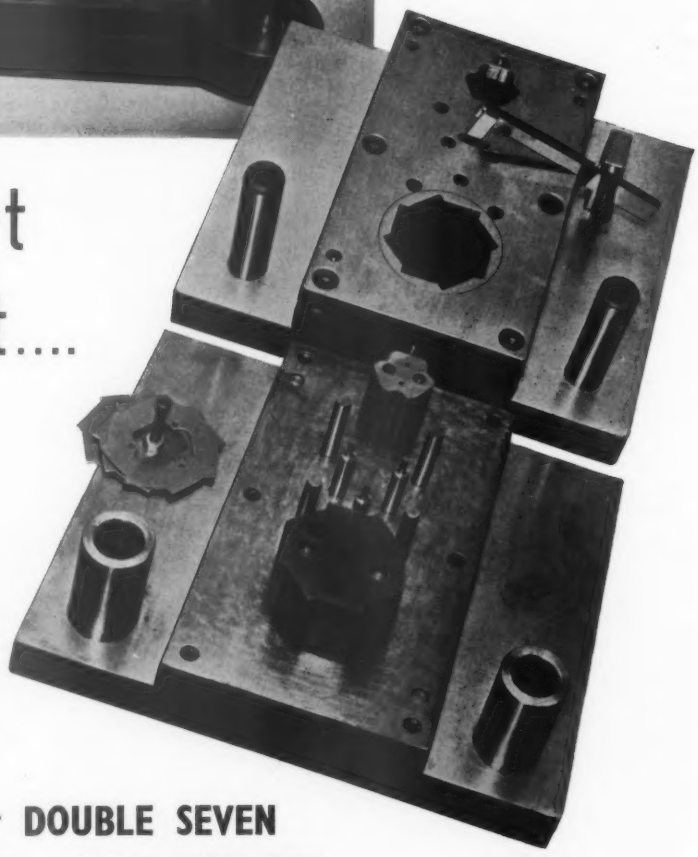
This new standard specifies requirements for cables having an insulation of PVC compound and glass braid with a protective covering of nylon. Provision is also made for a range of cables with an outer covering of metal braid.

The cables are suitable for use in aircraft circuits in which the voltage between conductors, between the conductor and metal braid surrounding it and between a conductor and the aircraft structure does not exceed 600 V (r.m.s.), the frequency does not exceed 1600 c/s. and where, in continuous service, no combination of ambient temperature and conductor current produces a stabilized conductor temperature in excess of 90° C.

The standard specifies the requirements for materials used in the construction of the cables, dimensions, identification, packing and labelling.

British Standards Institution, 2 Park Street, London W1.





Putting a quart into a pint pot....

It almost seems like it, when you think of how much experience Edgar Allen put into the making of steel for dies. The overflow is well taken care of, though, because our knowledge isn't all confined to just one steel—we make nine alloy steels for different applications, in addition to water-hardening carbon tool steels. From blanking, thread-rolling and tin-making to aluminum die-casting, there are many applications that an Edgar Allen die steel is made to fulfil!

DOUBLE SIX · DOUBLE SEVEN
K·9 · MINERVA · No. 5 HOT DIE
MAXINIUM · LOMINIUM
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Please post 'Special Alloy Tool Steel' booklet to:
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BUSINESS & PROFESSIONAL

Personal

Dr. W. P. Mansfield has been appointed to succeed **Engineer Rear-Admiral D. J. Hoare** as director of research to The British Internal Combustion Engine Research Association at the end of this month, when Rear-Admiral Hoare will retire. Dr. Mansfield joined BICERA in charge of its research station in 1944.

Mr. C. P. McCallum has been appointed area manager of Alldays & Onions Limited, engineers, Sydenham Road, Small Heath, Birmingham 11, as from January 1, 1958. The area covers the counties of Lancashire, Cheshire, Flintshire, Denbighshire, Caernarvonshire and Anglesey. Mr. McCallum has been connected with the fan industry for upwards of 30 years.

Two appointments to the sales staff of Bowmaker (Plant) Limited of Willenhall have recently been made. **Mr. J. G. Roberts** becomes sales representative for the North Wales area covering as far South as Aberystwyth. He has been with the company since 1941. **Mr. R. J. Cooper** is sales representative for North and East Gloucestershire, Worcestershire and Herefordshire. Mr. Cooper served at the Military College of Science until he joined the Civil Service when he became a technical workshop officer in the Middle East.

Mr. W. H. Apthorpe, managing director of Cambridge Instrument Company Limited, retired from executive duties at the end of last year but has retained his seat on the board, and will continue to be available for special duties as deputy chairman. He is succeeded as managing director by **Mr. H. C. Pritchard,** who has held a senior position with Elliott Bros. Limited and who has had a distinguished scientific and administrative career.

EDGAR ALLEN & COMPANY LIMITED announce the retirement last year of **Mr. Percy George Ryder,** technical representative, **Mr. W. A. Longden,** commercial manager of the steel foundry department, and **Mr. Arthur T. Willis** of the steel foundry division. **Mr. George Slater** was appointed chief draughtsman of the trackwork department in succession to **Mr. T. Samson** who resigned to take up a scholastic appointment.

RENOLD CHAINS LIMITED announces that **Mr. J. P. Halpin** has been appointed a director of the company.

CONSEQUENT on the retirement last October of **Mr. J. F. Perry** from the board of Metropolitan-Vickers Electrical Export Company Limited of which he was managing director, and from the board of the parent company—Metropolitan-Vickers Electrical Company Limited—**Mr. F. R. Mason** was appointed managing director and **Mr. H. F. Bibby** succeeded Mr. Mason as the Export Company's general manager. Mr. Perry also resigned from the board of the parent company, Metropolitan-Vickers Electrical Company Limited. Concurrently Mr. Mason was appointed to the boards of Metropolitan-Vickers Electrical Company Limited and Associated Electrical Industries Overseas, Limited.

Mr. H. B. Lloyd, technical services superintendent at Workington Iron and Steel Company, a branch of The United Steel Companies, Limited, has left the company to take up another appointment, and has been succeeded by **Mr. D. R. G. Davies,** former chief chemist and control metallurgist. **Mr. L. Jackson** has succeeded Mr. Davies as chief chemist.

THE MOND NICKEL COMPANY LIMITED announces that **Major Cuthbert Johnson,** manager of the company's precious metals refinery, relinquished his appointment on December 31, having reached retirement age. During his 38 years service with the company, Major Johnson was responsible for their precious metals production in this country. He has been succeeded by **Mr. A. R. Raper.**

Mr. A. P. Gibbs, North West area manager for Ransome & Marles Bearing Company Limited, Newark-on-Trent, has taken up an appointment at head office. **Mr. H. V. Willder** has succeeded him at Manchester and is now assisted by **Mr. E. L. Paton.** The Liverpool sub-office manager is **Mr. G. H. Walker,** former stores supervisor.

Mr. W. T. Vizer-Harmer, director and commercial manager of Steel, Peech and Tozer (branch of The United Steel Companies Limited), has now been appointed commercial director of the branch. He has been succeeded as commercial manager by **Mr. J. Mackenzie-Mair** who is responsible for all commercial and sales matters.

AFTER an association with Messrs. Johnson & Phillips, Limited, which had lasted for half a century, **Mr. G. Leslie Wates, J.P., Comp. I.E.E.,** found it necessary in October last, owing to prolonged illness, to resign from the chairmanship of that company, a position which he had held for twenty-six years. He remains on the board and has accepted the honorary office of president. He is succeeded as chairman by **Mr. W. Glass, M.I.Mech.E.** Mr. Glass joined Johnson & Phillips Limited twenty-five years ago and was appointed a director in 1941. In 1947 he became joint managing director and, early last year, managing director, a position he will continue to hold.

Sir William Wallace, C.B.E., LL.D., F.R.S.E., M.I.Mech.E., M.I.N.A., retired in December from the office of managing director of Brown Brothers & Company Limited, Rosebank Ironworks, Edinburgh, on the completion of forty years service in that capacity. Sir William will continue to serve as a director and as chairman of the board. **Mr. C. C. Mitchell, O.B.E., B.Sc., M.I.Mech.E., A.F.R.Ae.S.,** has been appointed managing director.

Obituary

WE regret to record the death of **Mr. J. Harold Brown,** a former chairman of Sanderson Brothers and Newbould Limited. Mr. Brown, who was 84, retired from the board at the end of 1955. He had been chairman since 1938 and a director for 25 years.

Addresses

BRITISH INSULATED CALLENDER'S CABLES Limited have opened a new depot at 511 Roumelia Lane, Boscombe, Hants., (telephone Boscombe 36223). Stocks will include a comprehensive range of wiring types of cables and accessories. Mr. A. J. Pearson will be in charge of the new depot.

THE DATA RECORDING INSTRUMENT Company Limited, manufacturers of tape recording equipment and multi-track heads, have taken larger premises at Woodthorpe Road, Ashford, Middlesex following the introduction of additional capital into the business by The British Tabulating Machine Company Limited. This will enable the company to extend its research. The board has been strengthened by the appointment of three directors from The British Tabulating Machine Company Limited while continuing to operate as an independent unit.

IN order to provide industrial firms in Scotland with a centre for information and advice on material handling equipment Fisher & Ludlow have now opened their new Scottish office at Fisholow House, Fife Crescent, Bothwell, Glasgow, in charge of Mr. F. P. Whiteley.

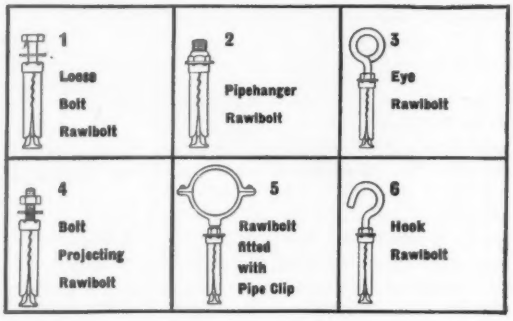
THE address of the Department of Work Study and Staff Training of the Engineering & Allied Employers' West of England Association is now Engineers' House, The Promenade, Clifton Down, Bristol 8. The Queen Square offices of the Association have also moved to this address and the common telephone number is Bristol 31931 (5 lines).

Rawlbolt charts showing full range of sizes and types with illustrated literature available on receipt of letter-heading or business card.

6 HEADS are better than one!

You never need to improvise with Rawlbolts. There are types exactly right for every bolt-fixing job, No. 5, for example, for the support of pipe-work, and No. 2 for use with Pipe-hangers and other gas fittings. Hook and Eye Rawlbolts (Nos. 3 and 6) have many uses, such as providing anchorage for guy ropes and cables, supporting suspended ceilings, etc. There's the Loose Bolt Rawlbolt (No. 1), inserted after the machine is slid into position, and the Bolt Projecting Type (No. 4), ideal for wall-fixings.

Rawlbolts give you bolt-fixings of enormous strength in a fraction of the time taken by any other method.



Every bolt-fixing job is far quicker with

RAWLBOLTS

THE RAWLPLUG CO. LTD., RAWLPLUG CROMWELL RD., LONDON, S.W.7

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Contracts and Work in Progress

NU-SWIFT LIMITED, Elland, Yorks.—Order from A.T.A.C., the Municipal Traffic Combine of the City of Rome, for pressure-charged operated fire extinguishers. This is the first order in a programme of standardization by the Italian authority on Nu-Swift fire extinguishers.

DOULTON INDUSTRIAL PORCELAINS, Tamworth, Staffs.—Ceramic bushing insulators (180 kV) for The Canadian General Electric Company of Toronto. Monthly consignments over a twelve month period.

F. PERKINS LIMITED, Peterborough, Northants.—Order totalling nearly $80,000 for marine engines from the India Supply Mission in Washington calling for twin sets of Perkins P6(M) and P4(M) marine diesel engines, with stern gear and controls, to be used for motor launches operated by the Central Water Power Commission in India.

METROPOLITAN-VICKERS ELECTRICAL Export Company Limited.—Orders for transformers and switchgear from the Electricity Trust of South Australia through Australian Electrical Industries (Pty) Limited, to a total value of approximately half a million pounds. They include equipment for Port Augusta 'B' power station and Magill substation.

AUTOMATIC TELEPHONE & ELECTRIC Company Limited.—Further orders valued at over £76,000 for telegraph distortion measuring sets and electronic regenerative repeaters, from U.S. Air Force in the U.K. The telegraph equipment is being manufactured by A.T.E. (Bridgnorth) Limited.

PYE TELECOMMUNICATIONS LIMITED, Cambridge.—Among contracts received recently from Canada one valued at over $100,000 is for radio telephone equipment for the Veterans' Taxi Cab Company of Montreal.

THE following contracts have been placed by the Scottish Region of British Transport Commission: John Stirk & Sons Limited, Halifax —Two planing machines, St. Rollox Works, Glasgow. Westinghouse Brake & Signal Company Limited, London — Provision of colour light signalling, Newton.

Trans-atlantic TV Cable

A trans-atlantic television cable between the United Kingdom and Canada which could have an enormous influence on trade between the two countries, is envisaged by Mr. C. O. Stanley, chairman and managing director of the Pye group of companies. Before the return of the Canadian Trade Delegation recently, members attended a private electronics exhibition when Mr. Stanley put forward his suggestion for a television cable which would pay its way by the sale of live programmes and by carrying hundreds of telephone circuits during non-TV hours. Mr. Stanley thought that the development of submarine transistor amplifiers should make the project possible and his company would be very willing to co-operate in the research necessary to make transistors available. He said that reception of American television programmes had greatly influenced Canadian trade away from Britain.

New Research Group

THE formation of a new engineering group is announced by Marconi Instruments Limited, St. Albans to conduct general research investigations, research in connexion with nucleonics, technical liaison with other research organizations, and the applications of semi-conductors to the company's products. The engineer-in-charge of this new group is Mr. G. M. Ettinger, M.Sc., who previously held a senior post at the Whetstone Laboratories of the English Electric Company Limited, and has had considerable experience in connexion with transistors and magnetic amplifiers.

Cleveland Twist Drills

TWIST drills are now being made in Scotland by Cleveland Twist Drills (G.B.) Limited to the same exacting standards which have made the name Cleveland synonymous for the past 80 years or so. The British agents are E. P. Barrus (Concessionaires) Limited, 12-16 Brunel Road, Acton, London, W3.

Dispersion Coating of Polytetrafluoroethylene

FOR the coating of articles of all sizes with P.T.F.E. Dispersion, newly installed plant at the new factory of Siemens Edison Swan Limited, in Tottenham includes sintering ovens capable of accepting parts equivalent in size to a double-decker bus, and conveyor ovens will handle large quantities of small parts. This process results in a completely inert and non-stick surface with an almost zero co-efficient of friction.

Modern Steam Accumulators for Canadian Industry

THE STEAM STORAGE COMPANY LIMITED, of Leeds, England, manufacturers of steam accumulators and specialists in this field for many years, have recently opened a Canadian branch with headquarters in Toronto, Ontario, and, in association with Dominion Bridge Company Limited of Montreal, well known throughout Canada as boiler manufacturers, will manufacture and install steam accumulators for the North American market. Thus British technique and experience in this specialized field are now being made available to Canadian industry.

Company Acquisition

THE whole of the share capital of Designs and Installations Limited has been acquired by Southern Areas Electric Corporation Limited of 28 Queen Anne's Gate, London SW1. Besides the factory at Guildford manufacturing labour saving machinery for the wrapping and packaging of goods, Designs and Installations Limited has a team of designers at their London office engaged on the solution of handling problems connected with nuclear reactors. Southern Areas Electric Corporation Limited envisage a considerable expansion in several fields of electronics.

Airtech New Division

AIRTECH LIMITED, manufacturers of hydraulic and pneumatic components and engineering products, have now formed an engineering division under Mr. P. J. Langdon as sales manager. A consultant design service for complete hydraulic and pneumatic systems is now available to industry at home and overseas.

Pyrene Acquisition

THE PYRENE COMPANY LIMITED of Brentford have acquired additional trade marks, patents, sales and manufacturing rights hitherto owned by the American Pyrene Company, and will thus be able to develop a substantial export market in South and Central America, and a number of European countries, areas where trading has hitherto been restricted, and outside the United States will have a world market for their products.

Wakefield Chemical Products

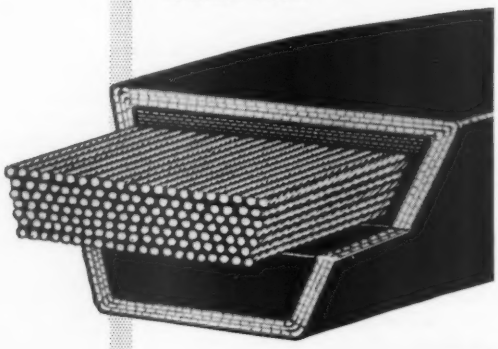
CERTAIN of the chemical additives produced and used by C. C. Wakefield & Company Limited will now be available to the outside market, together with other chemical products. The marketing of the chemical products of the Wakefield group of companies will be carried out through its member company, Edwin Cooper & Company Limited—the board of which has been reconstituted as follows: Mr. L. M. Broadway, chairman; Mr. W. Helmore, deputy chairman; Mr. G. H. Thornley, managing director; Messrs. W. F. List, G. E. T. Eyston, J. A. V. Watson, L. G. Packham, L. Colkett, secretary; J. C. Cragg and C. R. Woodfield.

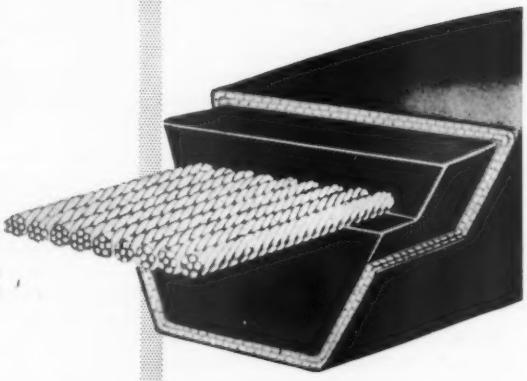
Pulsometer Acquisition

THE PULSOMETER ENGINEERING COMPANY Limited, of Reading, have acquired the controlling interest in G. S. Tett & Company Limited, water softener consultants and manufacturers, of Bedfont Lane, Feltham, Middlesex. Mr. F. B. Duncan (chairman) and Mr. J. S. Woodrow (managing director) of Pulsometer have joined the board of G. S. Tett & Company Limited.

V-BELTS THAT ARE BUILT TO LAST!

on multi-V Drives





and on F.H.P. Drives

YOU BUY ENDURANCE when you buy Goodyear V-Belts, made in types and sizes to suit every job from the largest multi-V installations to small F.H.P. drives. Longer belt life, more efficient transmission, less risk of costly shut-downs — these are the positive benefits of making good use of the Goodyear 'job-designed' range of belts which are backed by more than fifty years' experience in rubber engineering.

To be sure of longest, most economical performance it pays to consult Goodyear or your Goodyear Industrial Distributor, who will recommend a suitable belt, and also advise on installation and maintenance.

GOODYEAR

V-Belts · Conveyor Belting · Transmission Belting · Hose · Fenders

THE GOODYEAR TYRE & RUBBER COMPANY (GREAT BRITAIN) LIMITED · WOLVERHAMPTON

'Aeroweb'—Honeycomb Core

AERO RESEARCH LIMITED honeycomb will, in future, be marketed under the registered trade name of 'Aeroweb'. Aeroweb metal honeycomb core is used in conjunction with Redux adhesive in film form for the production of sandwich panels for aircraft, boats, motor vehicles and other industrial applications where a high strength/weight ratio is required. It is suitable for flat surfaces of constant or tapering thickness, as well as for shapes involving single or double curvature.

Dictaphone Expansion

THE deal for a further factory at Acton, London, recently concluded with the Pearl Assurance Company Limited, by the Dictaphone Company Limited will double the company's manufacturing capacity and give them four factories in Acton. It will be used to increase the factory floor production of Time-Master dictating machines and to begin the manufacture of the Dictet, a new lightweight, portable, on-the-spot recorder.

Film News

The Hydulignum Story.—This 40-minute film in 16 and 35 mm—sound—which had its première at the British Council Film Theatre last December, describes the manufacture of Hydulignum densified wood laminates and its various applications for press tools, aircraft propeller blades and many other purposes. Showings are now being arranged for several major centres at home and overseas. Hordern Richmond Limited is a member of the Permali group of companies which specializes in the production of densified wood laminates for industry. Further particulars may be obtained from D. R. P. Booth, Hordern Richmond Limited, Haddenham, Bucks. Tel: Aylesbury 444.

The Wickman Erodomatic.—The rapidly developing technique of spark-machining is the subject of this new 16 mm colour film, produced by Wickman Limited, of Coventry. The film runs for about 17 min. It shows the nature of spark-machining and illustrates the equipment necessary for the process. Production examples include the drilling of 0.008 in. holes in hardened steel ball bearings and deep holes in Nimonic 90.

Copies of the film, which carries a fully descriptive commentary, will be available for loan in the near future, and a companion booklet is in course of preparation.

Dunlop Film Library.—Four films, one of which deals with work study as a production technique, have now been added to the Dunlop Film Library. All Dunlop films are lent free of charge to associations and clubs which have suitable equipment for the projection of sound-on-film prints.

Megator U.S.A. Subsidiary

A subsidiary company has been formed in the U.S.A. by Megator Pumps & Compressors Limited (43 Berkeley Square, London W1) to handle their American business in industrial and marine self-priming pumps. The new company, known as Megator Pumps & Compressors Inc., will be responsible for marketing Megator pump sets—produced in the U.K. by the parent company to American standards—throughout the United States, and will provide efficient after-sales service when required. The address of the new company is 930 Manchester Avenue, Pittsburgh 12, Pa.

B.N.E.C. New Member

THE INSTITUTE OF FUEL has been admitted to membership of The British Nuclear Energy Conference. The purpose of the conference is to co-ordinate the activities of the constituent members in the field of nuclear energy; meetings are held and a journal is published. The conference has been strengthened by the inclusion of the interests of fuel technology. The constituent societies of the B.N.E.C. now number eight: namely, The Institutions of Civil, of Mechanical, of Electrical, and of Chemical Engineers; The Institutes of Physics, of Metals and of Fuel, and The Iron and Steel Institute. The offices are at 1-7 Great George Street, London SW1, and the board is under the chairmanship of Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S.

European Federation of Chemical Engineering

THE INSTITUTION OF CHEMICAL ENGINEERS has now joined the European Federation of Chemical Engineering. The object of the Federation is "the furthering of European co-operation in the field of chemical engineering, which includes chemical apparatus and equipment, chemical process technology, materials as applied in the industry, and basic chemical operations". The Federation now has secretariats as follows: DECHEMA, Deutsche Gesellschaft für Chemisches Appatewesen, in Frankfurt am Main; The Institution of Chemical Engineers, in London; and Société de Chimie Industrielle, in Paris.

I.C.I. and Yorkshire Copper Works

A JOINT enterprise is envisaged by Imperial Chemical Industries and Yorkshire Copper Works Limited, in which I.C.I. would contribute various copper and copper tube works and Yorkshire Copper Works would contribute its large copper works at Leeds and other interests. The plants of the two companies are in many instances complementary, and their utilization in a joint enterprise would enable production facilities to be used with the utmost efficiency the better to compete in vital overseas markets and in the likely Free Trade Area in Europe.

British Firms' Joint Enterprise

FOUR British companies—Higgs and Hill Limited, James Burness and Sons Limited, The Brush Group Limited and Brian Colquhoun and Partners—have formed a consortium to build a shipyard in Cuba and 25 ships for carrying sugar, iron ore, other bulk commodities and general cargo. The companies have signed a declaration of common purpose with Banco de Desarollo Economico y Social (BANDES) with the co-operation of Banco Cubano del Comericio Exterior. The total cost has been put at £30M.

Sonde Place Research Laboratories

THE 2750 sq ft extension to the Sonde Place Research Laboratories at Dorking, Surrey, is being built by Hewitt's of Cranleigh, specialists in industrial pre-fabricated, tailor-made, reinforced concrete clear span buildings. The building is 60 ft by 45 ft and 10 ft to eaves and is infilled with the patent Cranley heat-insulating concrete panels.

Linear Ball Bushings

RANSOME AND MARLES BEARING COMPANY Limited have acquired the exclusive British rights for the manufacture and sale of Thomson Ball Bushings, linear bearings which are widely used in America. Enquiries should be sent to Ransome and Marles' head office at Newark-on-Trent.

Varian U.K. Agent

LIVINGSTONE LABORATORIES LIMITED, Retcar Street, London N19, has recently been appointed exclusive representative in England, Wales, Scotland, Northern Ireland and Eire of The Tube Division of Varian Associates of California, micro wave tube manufacturers.

New 600 Agency

GEORGE COHEN SONS & COMPANY LIMITED are now sole agents in Great Britain for the Dorst Automatic press for powder metallurgical applications, now widely used in the U.S.A. The press is available in a range from 10 to 100 tons pressure.

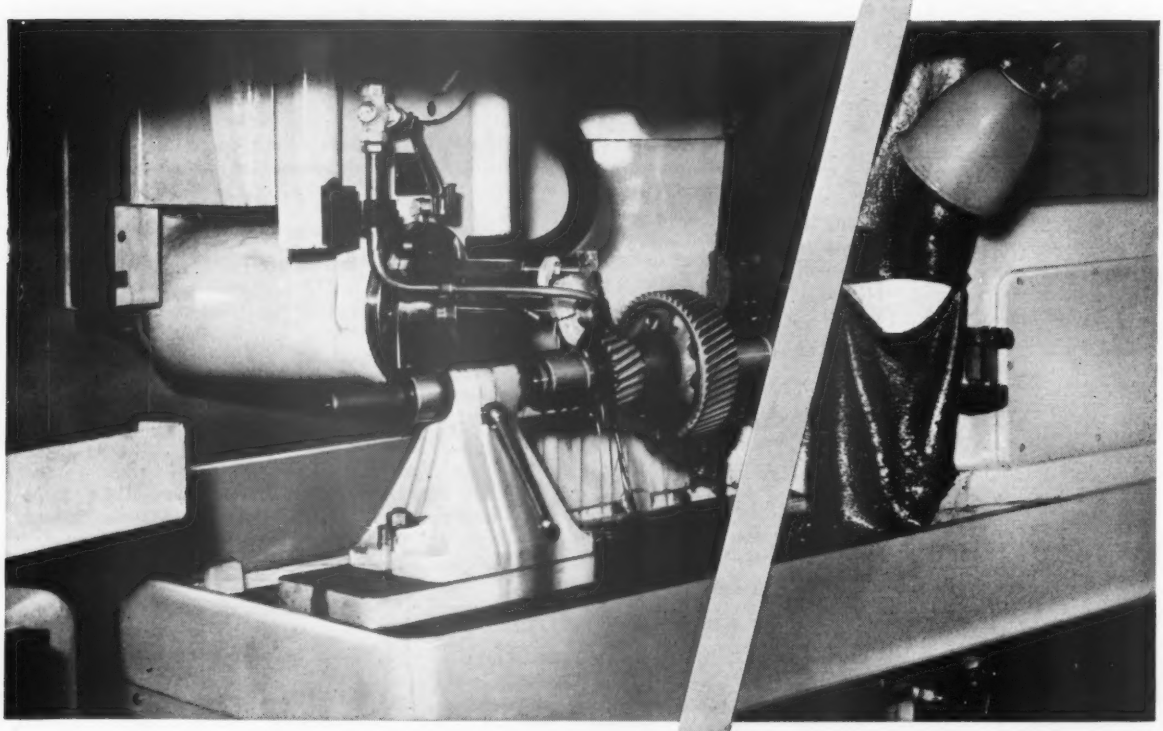
——— *Erratum*

"Trouble with Deep Drawing".—Our technique pages of December last referred to a suitable steel for dies made by Edgar Allen & Company Limited of Sheffield. A misprint occurred in the name of the steel which is, of course, their well-known Double Six. Also, the reference in the last paragraph in the question should be to "bore quenching" steel.

"ILOCUT"

NEAT CUTTING OILS

and the ROLLS-ROYCE *Dart 510*



Orcutt H.K.N. External Helical Gear Grinding machine grinding low-speed teeth of Dart 510 propeller turbine layshaft at Derby with "Ilocut"

"Ilocut" is Wakefield-Dick's best known range of neat cutting oils. Its high quality never varies—and it is specified by a number of this country's leading production engineers. Rolls-Royce Ltd. use "Ilocut" and many other of our production oils in their Aero Engine Division at Derby in addition to their Crewe, Barnoldswick and Glasgow works.

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WAKEFIELD-DICK INDUSTRIAL OILS LTD., 67 GROSVENOR STREET, LONDON, W.1

A MEMBER OF THE WORLD-WIDE WAKEFIELD CASTROL ORGANISATION

Special Purpose Papers

Four types of specialized papers in sheet, bulk, or in the form of multi-wall paper sacks are announced by Messrs. William Palfrey Limited, Palfrey House, 24 City Road, London EC1.

The papers are as follows: Seven-O Sized neutral papers chemically inert for use in contact with ferrous and non-ferrous metals; flame-resistant paper for the protection of goods in storage, base paper for reflective insulation, or filters for warm air heating systems; Nevermold 101, a non-corrosive mould resistant paper which is unaffected by humidity, rain, sunlight or other climatic conditions; and Scrimtex, a fibre-glass or rayon reinforced paper for exceptionally high tear resistance.

Cement for Industry

This is the title of a 32 page booklet which has been prepared by Lafarge Aluminous Cement Company Limited, 73 Brook Street, London W1 for plant and maintenance engineers. Four distinct sections cover each type of concrete, rapid setting, corrosion-resistant, refractory up to 1350° C, and insulating concrete up to 1000° C. Copies are available free of charge on application to the above address.

Colloidal Graphite—What is it?

This illustrated folder is a brief, straightforward answer, devoid of technical jargon, to the question posed in the title. The text should be of value and interest to the general as well as the lubrication engineer. The nature of a colloid is defined, the advantages of graphite and colloidal graphite as a lubricant are discussed and supported by test data.

Copies can be obtained from Acheson Colloids Limited, 18 Pall Mall, London SW1.

Flexible Couplings

Three distinct types of flexible couplings are illustrated in a new leaflet issued by Howard Clayton-Wright Limited, Wellisbourne, Warwickshire. The Harrisflex (Torflex) coupling meets the demand for a flexible unit of simple design which dispenses with the need for keyways and which permits a certain amount of alignment latitude. Torque is transmitted through the rubber bushes which are compressed on to the shafts by the action of tightening two right- or left-hand threaded caps to suit the direction of rotation. These couplings cater for shaft sizes of $\frac{1}{4}$ to $\frac{3}{4}$ in. diameter, with maximum torque values of 0·5 and 31 lb in. respectively. The Clayflex flexible coupling consists of two inner members, suitably bored and keywayed, and an outer shell which is in two halves. Rubber is bonded to the inner members and to the split outer member so as to leave axially disposed gaps between the halves of the outer shell. Finally an outer clamping ring is forced over the outer shell, to pre-stress the rubber, which also separates the two inner members by the resultant axial deformation. The maximum torque permissible using 1–1¼ in. shaft size coupling is 757 lb in.

For higher power ratings the flange type couplings using Clayflex flexible pin bearings are shown.

Hydraulic Elevator Truck

The latest addition to the Powell Vertolifter range of hand operated hydraulic elevator trucks incorporates a platform, 20 in. long × 21 in. wide and is available with two heights of lift, 48 in. and 60 in.

The truck is robustly constructed for a load capacity of 500 lb and all moving parts have either ball or roller bearings. The hydraulic pump is double acting and finger tip control permits the load to be lowered swiftly or slowly with instant stopping at any point. The makers are Powell & Company, Burry Port, Carms, South Wales.

Trade Literature

Ground Flat Steel Sections

An up to date price list covering precision carbon chrome alloy steel ground flat stock has been published by T. Norton & Company Limited, Carver Street, Birmingham 1. The standard limits given for thickness are ±·001 in. Full heat treatment instructions are also provided.

Galvanized Work Trays

Work trays strongly made of 22–24 gauge galvanized steel with wired rims and drop handles are illustrated in a leaflet issued by The Welconstruct Company Limited, 28 Martineau Street, Birmingham 2. Two sizes are shown, 12 × 12 × 6 in. and 24 × 12 × 6 in.

Alkaline Metal Cleaner

Pyroclean No. 6 a new mild alkali type cleaner for cleaning ferrous and non-ferrous metals, including zinc and zinc base alloy components and aluminium is available in powder form and it is operated in an aqueous solution usually at a temperature of from 190–205° F. It can be used in still tanks or in spray machines of the orthodox type and automatic plants of the conveyorized or spray types. The processing time is from 5–10 minutes for an immersion plant and approximately one minute for a spray machine. Full details are contained in a leaflet issued by The Pyrene Company Limited—Metal Finishing Division, Great West Road, Brentford, Middx.

Crate Stacking

Stacking crates, boxes or other rigid containers in regular columns is a process common in many packing and despatching departments. The Universal stacker made by U.D. Engineering Company Limited, Abbey Works, Amberland Avenue, Park Royal, London NW10, can be arranged to stack cases up to seven high if the maximum height of the case does not exceed 10½ in. The stacker is installed in the line and is entirely automatic in operation. It is self-contained with power-driven feed-in and discharge conveyor, the number of crates or cases, etc., to be stacked in each column is predetermined by the setting of the switch. The standard machine will handle and stack up to twenty-two crates or cases per min, i.e. 1320 units per hr.

Calendars

Once again The Brush Group Limited, Duke's Court, Duke Street, St. James, London SW1, have issued an outstanding calendar of seasonal views of the English countryside which are reproduced in full colour.

Edgar Allen & Company Limited, Imperial Steel Works, Sheffield 9 have chosen a series of colour views of the historic homes of Derbyshire and Yorkshire. Each view is accompanied with short descriptive notes.

Cornish coastal scenes have long been the choice of subject for calendars issued by Holman Bros. Limited, Cambourne, Cornwall. This year is no exception, the subject being Low Tide at St. Ives, a painting by Hugh E. Ridge.

From Mavor & Coulson Limited, Bridgeton, Glasgow SE , comes a coloured reproduction of a photograph the Loch Laggan Hills and from British Thompson-Houston Company Limited, Rugby, a monthly tear sheet calendar of landscape photographs.

Other calendars have been received from Brook Motors Limited, Huddersfield, Midland Electric Manufacturing Company Limited, Tyseley, Birmingham, The Northern Manufacturing Company Limited, Albion Works, Gainsborough, Lincs., The Hunslet Engine Company Limited, Jack Lane, Leeds 10, Le Bas Tube Company Limited, City Wall House, Finsbury Pavement, London EC2, Hadfields Limited, East Hecla Works, Sheffield 9 and Coventry Gauge and Tool Company Limited, Coventry.

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TRADE MARKS
B·S·A TOOLS GROUP

Aspatria (Cumberland). John Laing and Sons, Dalston Road, Carlisle have received the contract for the construction of a creamery (second stage) for the Milk Marketing Board.

Billingham-on-Tees. British Titan Products, Limited, are to erect a four storey office block at Haverton Hill Road and have prepared their own plans.

Birtley (Durham). Gorrills Limited, Corporation Street, Newcastle-on-Tyne are to erect a factory at Vigo Lane, Birtley.

Carlisle. Additions are proposed in Kings Arms Lane for Dias and Company Limited. The architect is G. W. Danson, 54 Lowther Street, Carlisle.

Darlington. The Town Council is to spend £5,000 on the construction of a chassis spraying shed at the Corporation transport depot. The Borough Engineer is Mr. G. S. Short, Town Hall, Darlington.

Durham. The County Council has received an inquiry from a South of England firm regarding suitable sites in the North-East for the erection of a £300,000 factory covering 120,000 sq ft. A further £500,000 is proposed to be spent on equipment and machinery for the premises. One of the sites under consideration is at Jarrow.

Eston. South Durham Steel and Iron Company Limited, Middlesbrough are to erect a battery of 52 coke-ovens at South Bank-on-Tees.

Gateshead. The builders for Armstrong Whitworth and Company Limited new machine shop at Coulthards Lane are Bewley and Scott Limited, Dunston-on-Tyne.

Tenders are to be obtained by the Town Council for repairs to Hillgate Quay. The cost will be about £7,000 and the consulting engineers are R. T. James and Partners, Clavering Place, Newcastle-on-Tyne.

Hartlepool. The Richmond Construction Company Limited, West Hartlepool are negotiating for the purchase of land at Spion Kop for the erection of a light engineering factory.

Additions are proposed tothe Central Marine Engine Works of William Gray and Company Limited. The work is to be done by direct labour.

Hebburn-on-Tyne. Work has started on additions to the Bedewell Works of Baker Perkins Limited, the builders are Bewley and Scott Limited, Dunston-on-Tyne.

The largest dry dock on the North-East is to be constructed at the Hebburn works of Vickers-Armstrong (Shipbuilders), Limited. The dock will initially accommodate ships up to 85,000 tons, but later will be enlarged to cope with vessels of 100,000 tons d.w. Consulting engineers are T. F. Burns and Partners, 3 Ellison Place, Newcastle-on-Tyne and London.

A. Anderson Limited, Stanmore Road, have received the contract for the erection of research laboratories (second stage) for Reyrolle and Company Limited.

Howdon-on-Tyne. Armstrong and Banks Limited, Sandgate Quayside, Newcastle-on-Tyne are building by direct labour a small factory on the site of the former Northumberland Shipyard, Howdon.

Jarrow. Turley and Williamson, 46 Jesmond Road, Newcastle-on-Tyne are preparing plans for further factory additions on the Bede Trading Estate for Morganite Resistors Limited.

Whessoe Limited, Darlington, are the contractors for the erection of 14 storage tanks in connexion with additions to the Jarrow installation of Shell Mex and B.P. Limited. Some of the tanks will hold 10,000 tons.

Middlesbrough. Woodland Styles Limited, gown manufacturers, are to rebuild their premises in Albert Road. The architect is T. A. Crawford, 80 Borough Road.

R. Brown, 123 Victoria Road, Darlington, is the architect for a warehouse for John Sinclair Limited, tobacco manufacturers.

Newcastle-on-Tyne. Cackett, Burns Dick and MacKellar, 21 Ellison Place, are the architects for proposed offices in Shields Road for C. A. Parsons and Company Limited. The contractors are Stephen Easten Limited.

J. Rush and Company Limited, Stepney Bank, are to erect showrooms and offices, and have prepared their own plans.

M. Gatoff, 26 Mosley Street, has prepared plans for a warehouse and garage in Duke Street for N. Baker.

Goodlass Wall and Lead Industries Limited, Chester, are to erect smelting and refining shops at their Skinnerburn Works.

A contract will shortly be decided for the erection of an office block in West Road for R. Hood Haggie and Son Limited. Site preparation work is being carried out at present by Stanley Miller Limited, North Street. The architects are Cackett Burns Dick and Mackellar.

New Factories

North Shields. Smith's Dock Company Limited, shipbuilders and shiprepairers, are to spend £425,000 on improvements to their fitting and other shops at their yards at North Shields and South Bank (Yorks).

South Shields. Elsy and Gibbons Limited, ventilating engineers etc., Havelock Street, are negotiating for land in Maxwell Road for the erection of an engineering factory. The architects are Page, Son and Hill, 75 King Street.

Acton. Extensions are to be made to the factory in St. Leonards Road for Light Alloys Limited.

Barnsley. Extensions are to be made to the Railway Foundry for Qualter Hall & Company Limited.

Blackburn. A large plastics factory is to be built near Ewood for Imperial Chemical Industries Limited, Darwen.

Blackpool. Symbol Biscuits Limited, are to make extensions to the factory in Devonshire Road.

Burnley. Belling & Company Limited, are to make extensions to their factory at Heasandford.

Bridgwater. Nicholls & Barton, Waterloo House, St. Mary Street are the architects for extensions to the works of S. Leffman Limited, Provident Place.

Bristol. A new factory is to be built in Maggs Lane, Fishponds for City Engineering (Bristol) Limited.

Cardiff. The South Wales Blind Company Limited, 124 City Road are to erect a new factory at Pengam.

Carlisle. New factories are to be built at Durranhill industrial estate for Porter Engineering Company Limited, Denton and British Insulated Callenders Cables Limited, Finckle Street.

Coalville. The needle factory of T. Grieve & Company, Baker Street is to be extended.

Ealing. A new factory and offices are to be built for Walter Kidde & Company Limited, Engineers, Belvue Road, Northolt.

Harcold Refrigeration Company Limited, are to extend their factory in Walmgate Road.

Enfield. Extensions are to be made to the factory in Lincoln Road for Reeves & Son Limited.

Glasgow. John MacDonald & Company (Pneumatic Tools) Limited, are to re-locate their factory at Auldhouse Road.

Great Yarmouth. Extensions are to be made to the factory of the Hartmann Fibre Company Limited, Marine Parade South.

Haverhill. A new factory is to be built for the Mount Furnishing Company Limited, 8b Goose Yard, St. John Street, London EC1.

Hemel Hempstead. D. Clarke Hall, 6 Masons Yard, Duke Street, St. James's, London SW1, is the architect for the new factory to be built at Mark Road for Rota Finishes Limited.

Hounslow. Extensions are to be made to the factory of R. J. Coley & Son (Hounslow) Limited, Jubilee Works, Chapel Road. The architects are Brewer, Smith & Brewer, 38 Thames Street, Kingston.

London. G. Masservy, 340 Latimer Court, W6, is the architect for the new factory to be built on Broadway Estate, Hackney, for Latex Surgical Products Limited, 32 Rodney Street, N1.

A new factory is to be built at Edgware Road, NW9, for Imperial Machine Company, Victoria Works. The architects are Cassidy, Farrington & Dennys, 139 Kensington High Street.

Lytham St. Annes. Plans have been passed for the erection of a new light engineering factory on the Preston Road for North Cambrian Holdings Limited, 13 Whitefriars, Chester.

Macclesfield. A new factory is to be erected on the Hurdsfield estate for the Prestige Group Limited.

Margate. A new factory and offices are to be built at Ramsgate Road, Westwood, for L. W. Savage & Company Limited, packing case manufacturers, 72 Woolton Road, London SE8.

Newton Abbott. Plans have been approved for the erection of a new factory at Forde Road industrial estate for Pollards Confections Limited, 112 Queen Street.

Nuneaton. A new factory is to be built in Pool Road for Longford Woodcraft Limited, Longford Bridge, Bedworth Road, Coventry.

Portsmouth. Extensions are to be made to the factory in Rodney Road for Halmatic Limited.

Redditch. W. H. Smart & Company Limited, Wrentham Street, Birmingham 5, are to erect a new factory and offices in Arthur Street.

Rotherham. The Trubrite Steel Works in Fife Street is to be extended for Arthur Lee & Sons Limited.

Sheffield. A new factory is to be built in Matilda Street and Eyre Lane for Slack & Barlow (Sheffield) Limited, 14 Sycamore Street.

Swansea. A new works and offices are to be built in Slip Road, St. Thomas for H. Steele & Sons Limited, Albion Works.

West Bromwich. A new factory is to be erected in Brandon Way for J. R. Morris & Company Limited, engineers, 17 Harwood Street.

Wolverhampton. Extensions are to be made to the factory in Gable Street for Monmore Conduits Limited.

Extensions are to be made to Wobaston Works, Stafford Road for Bettles & Sons Limited, engineers.

Woking. Central Engineers (Herne Hill) Limited, 6 Griffiths Road, London SW19, are to erect a new factory at Sheerwater Estate.

Worthing. Extensions are to be made to the factory on Brookside Avenue, Rustingdon, for Greenwood & Airvac Ventilating Company Limited.

Classified Advertisements

Advertisements are inserted at the rate of 2/9d. per line, and should be sent to

31 King Street West, Manchester 3.

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DESIGNER Engineer Mechanic to take charge of design section in Anglo-American Company's London Office. Experience in automatic or packing machinery design an asset. Send full particulars of age, experience, present position and salary to Box No. SW4. "Mechanical World", 31 King Street West, Manchester, 3.

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The University Calendar may be consulted in the Library of any University which is a member of the A.U.B.C. Further information about the University or about any particular post will gladly be supplied on request to the Registrar.

APPLICATIONS must include particulars of age, nationality, marital status, academic record, teaching qualifications, war service (if any) and present position; a list of publications; copies of testimonials; the names and addresses of two referees of whom confidential enquiries may be made; a recent photograph; and a medical certificate of good health. They should be lodged in duplicate with the Registrar of the University, Adelaide, South Australia, not later that FEBRUARY 15th, 1958.

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